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THE
NATURAL HISTORY
AND
CULTIVATION OF THE SOLE.

BY

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[*PRIZE ESSAY.*]

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THE NATURAL HISTORY
AND
CULTIVATION OF THE SOLE.

OF all our commercial sea fishes there is, perhaps, not one that is more highly or more deservedly esteemed than the common sole. The flesh is firm, nutritious, and of delicate flavour; it is free from oil, and on that account it is a fish easy of digestion, and well suited to the requirements of the invalid. It is readily cooked, and prepared for a meal at a few minutes' notice. The sole, therefore, possesses all these important characters which have caused it to be more sought after than any other fish, by those persons who can afford to pay a high price for it. Of late years the comparative scarcity of this fish in relation to the great demand for it has caused it to become the most expensive article of sea-fish diet, and many people who formerly could afford to enjoy their favourite fish at a moderate cost, are now constrained to buy it but rarely, or to give it up altogether Let us first consider, (1) The natural history of the sole; (2) then those causes, if they exist, which have been alleged as creating a diminution of this fish in its own waters; (3) lastly, let us see whether the sole may be artificially cultivated, as we know to be possible and easy in respect of some of our freshwater fishes, notably the *Salmonidæ.*

The sole, *Solea vulgaris,* belongs to the family of *Pleuro-*

nectidæ, a word which in the Greek means "side swimmers." The term "flat fish" is the one usually employed to denote this family of fishes, but we must distinguish between these flat fish which are side swimmers, and other kinds of fishes also called flat fishes, I mean the rays and skates. The sole and all the Pleuronectids are flattened on the sides, the rays or skates are flattened from above. The upper surface of a skate, i.e. the dark or coloured portion, is the back ; the dark or coloured surface of a sole or other Pleuronectid is one of the sides. The skate swims on its belly like other vertically-swimming fishes ; the sole, turbot, flounder, &c., swim on one of their sides ; sometimes on the right side in some species, as in the turbot and brill (*Rhombus*), and sometimes on the left side, as in the sole (*Solea*) and plaice (*Pleuronectes*). It is a very curious and interesting fact, however, that this characteristic mode of swimming, or resting on the ground, among *Pleuronectidæ* is not very peculiar to the young fry of these fishes, which in their very earliest stage, after they have left the egg, swim in a vertical form like other fishes ; and not only so, but the eyes, instead of being both situated on the same, i.e. the coloured side of the body, as in the adult, are in the very young, one on the one side and the other on the other side of the little fish ; moreover, whereas as a rule, to which, however, there are occasional exceptions, one side is dark or coloured in the adult, in the very young fish both sides are coloured, and the numerous pigment cells are as well developed on the one side as on the other. This curious fact in the structure of the young of the *Pleuronectidæ*, though well known to those who have studied the natural history of fishes, is not known to the generality of people, and I find that fishermen are altogether unaware of this phenomenon, with here and there a solitary individual who has been in the habit of looking closely into the forms of the creatures he so constantly has an opportunity of capturing. And since, in any account of the natural history of the sole, it is desirable to speak of it "*usque ab ovo*," it will be well here to notice what has been absolutely observed in the case of young fishes of the same family as the sole. I am not aware whether the very early life of the sole has been definitely recorded by observers in this country or on the continent, but what is true of the young of some other flat fishes is probably and almost certainly true, in its general and characteristic features, of the young of the sole; so that although we are ignorant at present of the actual form of the early hatched fry of the sole, we are pretty safe in believing that its form and habits, at that time, differ in no important respects from the form and habits of those species in which this vertical form has been observed. A knowledge of the manner of spawning in fishes, the places which they frequent for that purpose, the mode of deposition of the ova, whether, as in the case of the herring, in a compact viscid mass of large or small size at the bottom, or on weeds or other submerged bodies, and in several other known sea-fish genera or species, or whether, as in the case of the many of the Pleuronectids, Gadoids, and other fishes, at or near the surface of the water, the conditions necessary for the development of the spawn, the places favourable for the growth of the fry, questions relating to currents, storms and temperature, the food of the young fry of fishes, the natural destructive agencies at work among them, all these are points in the natural history of all our fishes which we must know something of, if we expect to meet with any success in the propagation and cultivation of any particular kind. It is unfortunate that, with regard to the sole, there are many questions which still await investigation and explanation, but it is to be hoped that the interest excited by the International Exhibition will awaken in many observers a desire to penetrate into some of the mysteries of fish life, and especially into those connected with the natural history of the sole, whose claims present themselves with more than ordinary force and merit. Again, proposed legislative interference may be productive of much mischief, and thwart the very objects such interference has in view, unless it is based on a knowledge of the natural history of the fish which it is desirable or possible to protect from the effects of reckless modes of fishing, or from other injurious effects. The commonly accepted but now proved erroneous notion that all our sea fishes, except the herring, spawn near the bottom of the water, and that the trawl works unspeakable mischief by destroying the spawn, prevalent amongst so many of our fishermen, might have brought considerable loss to our fishery supplies, had any law been passed prohibiting trawling at certain times of the year or limiting the size of the mesh, &c. Now, from increased knowledge, we see the mischief that might have ensued ; very few of our sea fishes deposit their spawn in masses at the bottom ; nearly all, or at any rate the most important, of our commercial sea fishes emit their spawn near the surface, and there the eggs develop, and there the young fry for a time feed and disport themselves ; while there is little doubt that the sole is a surface spawner, and that its fry are in their early days vertical swimmers, with eyes one on each side of the head symmetrically arranged ; that both its sides are coloured, and that the changes that take place both in the position of the eyes, the mode of swimming, and the colouration are similar in general and essential respects to the changes which Professor Agassiz has observed to take place in the flounder. I will here give some account of what Professor Agassiz has made known with respect to the young state of the "flounder," because the subject is not only one of great interest in a zoological or physiological point of view, but what has been observed to take place in that fish may be considered as typical of analogous phenomena in the structure, colour, and habits of the young sole. "A young flounder," says Agassiz, "immediately after its escape from the egg, presents no special points of difference from the embryos of other bony fishes in a similar stage of growth. The young flounder has already attained a considerable size before any signs appear of the change in the position of the eye on the left side, and before the young fish shows the least tendency to favour one side more than another. Not until the young fish is fully three-eighths of an inch in length can the first slight difference be perceived in the position of the two eyes when seen from above. All young flounders, even long after they have all the characteristics of the adult, very frequently swim vertically for quite a length of time, or else swim near the surface with the undulating movement they have when swimming over the bottom, their heads well raised and bodies carried flat, parallel to the surface. Even quite old flounders are caught swimming near the top of the water. Almost all the stages were caught near the surface, swimming vertically like any other bony fishes; but this they do only when they come up to feed, while the water is very smooth, about ten in the morning, on very light sunny days, when they may be seen eagerly devouring swarms of embryo crustaceans of all orders. The young of other fishes seem to share this habit; for of the latter I have examined no less than twenty-five species, caught at various times with a hand-net, swimming near the surface of the water on bright sunny days, when not a ripple ruffled the sea. With the least movement, all the more delicate of these embryos vanish, leaving only the older and more vigorous, which in their turn disappear, and seek shelter in deeper water. Only when the young fishes are old enough to be recognised as the young of their tribes, do they venture to join them in their ordinary haunts. The habits of young flounders differ greatly from those of the adult; while the latter are generally more or less sluggish, the young flounders, when measuring less than a couple of inches in length, are remarkably active, bounding through the water, as it were, and if disturbed, frequently jumping out of the flat dishes in which I kept them." Dr. Alexander Agassiz's investigations, as above, refer to species of *Pleuronectes;* the same characteristic changes have also been observed by him in the genera *Rhombus* and *Pseudo-rhombus* and *Plagusia.* Whether Agassiz or any other observer has actually remarked the same changes of structure and habits to occur in those species of the genus *Solea* which are found on the Atlantic coasts of America, I am unable to say; but it is not too much, I think, to assume that analogous changes are characteristic of the genus *Solea*, and we may therefore be right in believing that the early life of the young sole differs in no essential particulars from the early life of the Pleuronectids generally. Indeed, it would be a very remarkable anomaly if the sole differed in these respects from the other members of the family of *Pleuronectidæ.* The sole has a wide geographical range, being found in the seas of Scandinavia up to latitude 62°, in the Baltic, where it does not penetrate very far, around the coasts of Great Britain and Ireland, and southwards into the Mediterranean. The soles of our southern coast are superior to those of the north; the warmer climate is better suited to this species, for the sole is very susceptible of cold, and either retires into deep water or hides in the mud or sand during severe weather. Sandy shores mixed with mud are its favourite places of resort, but it is very erratic, and any calculations as to the probability of finding its whereabouts are uncertain. The cold, however, nearly always drives the sole into deep water, into whose comparatively warm depths they will come from some distances, as is proved by the enormous captures occasionally made in what are called the "Silver Pits," or rather the "Outer Silver Pit," a patch of about 60 miles east and west, and from 6 to 10 miles wide, near the Dogger Bank in the North Sea.

With regard to their spawning, there seems to be no doubt that the usual time is in the spring, from February till about April; but, as in all other fishes, the time varies according to the temperature. They seem to frequent the shallower parts of our shores about the time of spawning, and like many other fishes appear to select shore water for this purpose, although it is not improbable that they often spawn also far away from land. The ova doubtless float like those of many other sea fishes, with whom floating ova seem to be the rule. Mr. J. Epton thought that small bunches of spawn, which he found in the summer of 1880 adhering to the warp of the net in the "Well" (North Sea), were those of the sole's eggs. He examined them carefully, and compared them with the eggs of soles spawning at the time. He speaks of them as hanging in suspension; one would be inclined to refer these suspended clusters as rather those of the squid or some molluscous creature; at the same time, I believe, the eggs of the sole after being deposited are as yet undetermined. Shallow water appears to be more or less essential to the development of the eggs of those fishes which deposit them on the ground, generally speaking;

this is especially noticeable in the *Salmonidæ*, which require a depth of three to four inches at least, not more. Perhaps the influence of the light and the more complete aëration of the water are the conditions the eggs require and meet with in shallow waters ; still there seems to be no definite rule herein, for the spawn of herrings is often met with in deep water some way out at sea. But for the floating ova light and air seem to be essential.

The growth of the sole, like that of all other fishes, depends in a great measure on the quantity of nutritive food it is able to take. Mr. Epton says that at one year old soles are about 2 to 4 inches in length ; at two years from 5 to 9 inches ; at four years some contain spawn ; and at five years they are large soles, and that they continue to grow slowly a few more years (' Fish and Fisheries,' p. 249).

The vicinity of a shore is more generally favourable to the growth of the young of fishes than the wide and open parts of the sea, on account of the profusion of life both of animal and vegetable nature that usually abounds there. Again, the neighbourhood of estuaries and large rivers which carry with them in their course great quantities of mud containing organisms in a living or decomposed or semi-decomposed state is favourable, because many fishes, and the sole especially, swallow large quantities of mud, and derive nourishment from the organic matter, often, it is true, of a microscopic size, which the mud contains. Hence the frequency with which we observe an abundance of young fishes near our coasts. Few people, unless they have microscopically examined the contents of fishes' stomachs to a considerable extent, are aware how much food fish derive from the mud which they swallow. The intestines of soles are often quite black from this cause ; and if the stomach and intestines be opened and the contents examined in a shallow vessel of water, the particles of sand and dirt at once reveal themselves. We can see in the case of our common earth-worms, we can see in the case of the well-known lugworm (*Arenicola piscatoria*), how sustaining to animal life is the soil of the land and the mud of the sea-shore. Large bodies are fed and nourished often by the smallest particles of food, provided those particles are taken into the stomach in large quantities.

If portions of the contents of a very small sole's stomach be examined under the microscope we shall find remains of minute chætopodous worms, themselves mud-eaters ; small entomostracous crustacea, and not unfrequently diatomaceæ ; very minute bivalve shells, and other things not easy to determine. As soon as the umbilical sac in an embryo fish has disappeared, so soon does it require food ; and excessively minute matter is only suitable for the tender mouth and stomach of the young sole. For the short space of time, I do not know for how many days, during which the young sole is a surface swimmer, its food must be obtained at or near to the surface. The surface food at this time consists of the minute particles of matter which the sea water always holds in suspension, floating alga, protophytes, and potozoa ; the young of the *Copepoda*; and other microscopic atoms of animal or vegetable life. As the young sole grows, it sinks to the bottom and draws its sustenance from thence. Fishes are, as a general rule, either surface swimmers or ground swimmers ; they are either within a few fathoms from the surface or near the bottom ; there does not appear to be an intermediate stratum where they habitually dwell. From researches made by Professor Agassiz in the United States Coast Survey steamer the *Blake*, in the summer of 1880 and 1881, it seems certain that there is no intermediate belt of animal life of any kind between those forms which live on the bottom or close to it, and the surface pelagic fauna ; that, in fact, the surface fauna of the sea is really limited to a comparatively narrow belt in point of depth. "As far as the pelagic fauna is concerned, those who have been in the habit of collecting surface animals know full well that the last ripple will send them below the reach of commotion. Müller and Baur were the first to adopt the use of a tow-net below the surface to collect pelagic animals when the water was disturbed. It seems natural to presume, as we have found from our experiments with the Sigsbee cylinder, that this surface fauna only sinks out of reach of the disturbances of the top, and does not extend downward to any great depth. The dependence of all the pelagic forms upon food which is most abundant at the surface or near it, would naturally keep them where they found it in greatest quantity. Of course, with the death or decomposition of the pelagic forms, they sink to the bottom fast enough to form an important part of the food-supply of the deep sea-animals, as can easily be ascertained by examining the intestines of the deep-water Echinoderms." These remarks of Prof. Agassiz are made more especially in connection with deep-sea forms of life, forms which can exist and thrive and multiply at a depth of even 2000 fathoms ; but they apply, I conceive, with equal force to those surface forms of organic life which are found in boundless profusion at certain times of the year in sea water whose depth is not much more than a few fathoms.

The young sole, if born in shallow water, has not many fathoms to sink ere it reaches the bottom ; and in such water, near the coast, there is almost always a profusion of minute living organisms which serve it as food. In deeper water, where young soles are undoubtedly found—I have seen young ones taken sixty miles or more from the land in the North Sea, in water about twenty fathoms deep—it is probable that they derive part of their food from the dead surface animals which, as Professor Moseley says, "fall as a constant rain" upon the deep-sea forms of life. Of course, at the bottom of the water young soles would find plenty of suitable food in living creatures there; food would be also found in the decomposed bodies of animals which perish as it were *in situ*, and which the water would hold in suspension. From an examination of a great number of soles, I cannot help laying stress on the large percentage of food which soles take into their systems, by swallowing, directly or indirectly, portions of mud which contain living organic forms and decomposed animal or vegetable matter; such food they will obtain both from the surface and the bottom. This fact has an important bearing on what will be said in connection with the question, "Will soles live and thrive in fresh water?"

Soles, when they arrive at maturity, are able to take food of a substantial nature in the shape of other fishes—crustacea, when not large, as crabs of various species; molluscs whether univalve or bivalve; but I have found in their stomachs more of the latter than the former, especially *Syndosmya alba*, adults and small, *Tellinæ*, young razor shells (*Solen*), and other thin-shelled bivalves; for the sole, unlike some of our other sea fishes, has not a "strong stomach," so far as its muscular walls are concerned, and I doubt whether hard-shelled univalves, though occasionally swallowed, form a large constituent in their diet. The sole is especially fond of worm-food, such as large lugworms (*Arenicola*), *Nereis* and *Eunice*, *Phyllodyce*, &c. I must here remark that the result of a great number of the examinations of various fishes' stomachs is only so far of value as an indication of the *general nature* of their food.

An examination shows what a fish has fed upon at the time it has been caught; it is quite probable that, were it possible to extend observations, various other kinds of food would be found in the soles' stomachs, sometimes of a kind that one would hardly expect. A sole may have a predilection for one kind of food more than for another, but food of some kind it must have, and therefore soles' food must depend upon the locality in which they are found, and the choice of locality is not always within the fish's own power, on account of temperature, currents, or other causes.

An important point which bears upon the artificial cultivation of the sole is its undoubted tenacity of life. I have taken soles of about four to six inches in length from a shrimper's net, have put them with a lot of other small fishes, as dabs, flounders, &c., in a collecting can, taken them home as they were, and set them in a cool place; whilst most of the other little fishes were dead, the soles were alive, after having been out of the water for twenty hours; and this tenacity of life is corroborated by fishermen who collect specimens for our aquaria. Soles do well in an aquarium, and there is no difficulty in getting them safely there. Why one fish should be tenacious of life, and another of the same family, and even of the same genus, should prove to be quite the reverse, is a fact difficult of solution. A closely allied species of the *Solea vulgaris*, for instance, the *S. minuta*, "solenette" or "little sole," soon dies in confinement. While out in a shrimping boat off Southport in April of the present year, collecting specimens for the aquarium, we caught a great number of "solenettes," but the fisherman said "they were no good," because they would not live in confinement many days, and this was confirmed in the case of those I brought home, for not a single individual survived.

I will here observe that, for any one interested in the natural history of fishes or any subject connected with marine zoology, a day with a shrimper will be sure to result in the acquisition of various treasures. In my investigations of the stomachs of fishes, I have always found it very difficult to get hold of the fishes before they were "gutted." If you buy a fish in the market it is almost always "cleaned;" the gills and stomach, &c., are taken out, and there is nothing left for the naturalist to examine if his object is the determination of the nature of the food. To examine the contents of a fish's stomach you must go out with a trawler or a shrimper, unless you have a boat and appliances of your own. Prime fish are nearly always gutted on board.

The finest soles are caught on our southern coast, as at Brixham and Plymouth and off the Cornish coast. Thompson's largest specimen was twenty inches in length. Mr. Grove received one from Torbay in February 1882, which measured twenty-four inches, and weighed 6½ pounds. Mr. Buckland had casts of a pair caught off the Irish coast which weighed twelve pounds; and Yarrell speaks of one weighing nine pounds, which measured the great size of twenty-six inches; and I suppose this to be about the largest recorded.

Soles are frequently anadromous; they are fond of the neighbourhood of estuaries and of ascending rivers for some miles, quite out of the reach of tidal influence. When I was in Devonshire I was told by the fishermen of the Dart that soles are often caught up the river as far as Totnes, and that they are very fine. An authority mentioned by Yarrell—a gentleman who resided on the banks of the Arun—writes: "I succeeded yesterday in seeing the person who caught the soles about which you enquire, and who has been in the constant habit of trawling for them with a ten-feet beam trawl for the last forty years. The season for taking them is May till November. They breed in the river (Arun), frequenting it from the mouth, five miles upwards, which is nearly to the town of Arundel, and remain in it the whole year, burying themselves in the sand during the cold months. The fisherman has occasionally taken them of large size, two pounds weight each, but frequently of one pound; and they are thicker in proportion than the soles usually caught at sea; in other respects precisely the same. And it is evident that they breed in great numbers in the river from the quantity of small ones about two inches long that are constantly brought on shore when drawing the net for grey mullet."

There can be little doubt that the superior size of all soles, as in other fishes, depends on a suitable locality where there is abundance of food easily obtained; much also depends on the climate; soles are not tolerant of severe cold; the further one goes north the less abundant and smaller in length and thickness they become; they find a more congenial home in the waters of the Mediterranean than in the Scandinavian seas; but suitable food is almost of more importance even than temperature; soles taken from clean sand, where there is no mud and where all animal and vegetable life is scant, do not grow to any size, nor have they the same flavour as those which live in ground where there is mud and rubble and a locality favourable for the development of animal and vegetal organisms. A case in point is, I think, to be found in another species of sole—the lemon sole, *Solea aurantiaca* of Günther. This fish must not be confounded with the so-called "lemon-sole" of our markets, which is not a sole but a species of dab, and which belongs to a different genus, viz. *Pleuronectes*.

The lemon sole is known to the fishermen of Devonshire as the "sand sole," and is occasionally brought into the markets at Plymouth and Brixham. This species is generally found in deep water, and does not occur near estuaries, and never ascends rivers; its peculiar colour, which simulates the clean sandy bottom on which it rests, bespeaks the nature of its habitat. Many kinds of fish, especially flat fish, whose resting-places are at the bottom, are known to assume the colour of the ground on which they are found; a dark coloured sole, if it were placed on clean gravel or sand, would soon represent in its coloration the complexion of the sand or gravel, simulating sometimes the pattern so admirably as to deceive spectators, who may pass a tank with several fishes at the bottom, without being aware of their existence unless he look closely or the fish stir. Soles of different colours are not unknown: thus we have "shrub" soles, from the dendritic shrub-like markings on the back, "spotted" soles: and even the term "lemon sole" is sometimes thus applied to our common species; but it is not usual to see soles of any other than the ordinary dark colour, if they have been taken out of the sea, and have not been kept in an aquarium. Pure arenaceous silex can nourish no form of animal life; and if a sandy bottom be deficient in mud, animal life of all kinds will be scant there, and those forms of life which do exist there will have to swallow very large quantities of the sand in order to find nutriment from it, as may be seen by noticing the contents of some of the stomachs of *Echinoderms*. The lemon sole is found nearly always on clean sandy bottoms; and its flesh is very inferior to that of the common sole, for it is soft and insipid compared with it. I may appear to dwell long, perhaps, on the question of food, but I do so designedly, because on it depends almost all other questions relating to fishes, and because it has a special bearing on the question of the artificial cultivation of the sole.

I have mentioned the lemon sole (*Solea aurantiaca; lascaris* of Day); it is at once distinguishable from the common sole, with which however it is occasionally sold, by its yellowish sandy or cinnamon colour. It is, however, a rare species on our coasts; though I have been in the habit of attending fish markets and looking into fishmongers' shops for many years, and have seen many fish of various kinds caught, I have only met with the lemon sole once, and this was at Torquay last year. Colour is not always a safe guide in determining a species, indeed it would be generally a most fallacious one—nevertheless in this case the colour of the lemon sole would nearly always bespeak its species; it has moreover certain structural characters which distinguish it from the common sole when of a yellowish colour, one of the most obvious of which is the large circular nostril on the blind side, which is surrounded by short but conspicuous filaments. Admirable figures of this species and of the other British species of soles will be found in Mr. Day's valuable work on *The Fishes of Great Britain and Ireland* now in course of publication.

Another species of sole, the variegated sole (*Solea variegata*), deserves especial mention from its excellence as an article of diet. I do not think I could distinguish in taste between this species and our common one; it is firm and of very good flavour. Great numbers of this fish are taken by the trawl at Plymouth and Brixham, where it is popularly known as the "thick-back," from its depth of body ; it is a small species, of about six to eight or nine inches in length, and is consumed largely in Devonshire and Cornwall by the people there, who are well aware of its excellence ; but it has only a local value, and seldom finds its way to London and to the markets in the interior of the country. This fish deserves to be better known. I do not know whether it is tenacious of life, like the common species ; if it were, it might be desirable to transfer it to other waters around our coast. When I was in Plymouth in October 1882, I was asked sixpence for four of these fish, and at that price one could have a delicious repast at a trifling expense. Mr. Dunn records in Day's work the capture of several hundreds at Plymouth in the month of February ; they averaged six to the pound, and "were being sold in pads, separated from the other soles, as offal." At Weymouth they are called "bastard soles." The variegated sole is of a brownish-grey or chesnut brown, with dark cross-bands on the body and fins, and is a very handsome fish.

A fourth species of sole completes the British list of the genus *Solea*, it is the *S. minuta* of Günther, the *S. lutea* of Day, and the "solenette" or "little sole" of Yarrell and Couch. This species is very small, and of no commercial value whatever ; its usual size is about four inches. It is known to fishermen by the name of the "little sole" or "red sole," as it has often a reddish tinge about it. I have seen immense numbers of this little fish taken in the trawl in Torbay, and have also captured in a shrimp-net off Southport great numbers of this same species. I mention it here because I think it quite probable that this fish is not discriminated by some persons who find such grievous fault with shrimpers and others whose small meshes must capture large numbers of fish-fry, and that very frequently the small soles thus taken are not the young of the common sole, but of the *Solea minuta.* I do not deny that the young sole proper is taken by the shrimp-nets, and often in considerable numbers, but where I have seen half-a-dozen true soles I have seen scores of the "little sole" thus captured. The solenette is of a dark greyish or reddish colour, with numerous darker spots on the body, which spots are sometimes absent. The dorsal and anal fins have some of their rays at intervals black or dark, and though the reddish coloured ones are readily known from the common sole, this is not the case on a cursory inspection with the brown individuals. I suspect that this little species is common on various parts of our coast, where the bottom is more or less sandy. Its food, like that of the young sole, consists of small *entomostraca* and particles of mud mixed with sand; and in a specimen I have under the microscope as I write, I find the acicular spicula mixed with the sarcode of some sponge. Another question proposed for consideration is—

Are there sufficient reasons to believe that the natural supply of soles is gradually becoming less, and, if so, is this alleged diminution due to over-fishing?

The evidence which I have been able to obtain on this matter is conflicting; some persons, chiefly the fish-dealers, have no hesitation in saying that the supply of soles is annually becoming scarcer and scarcer; others again, chiefly the fishermen, have told me that they do not consider any diminution is going on with respect to these fish, that their capture is and always has been uncertain, that they are convinced there are as many soles in the sea as ever there were; "but," say they, "we cannot always drop across them;" and it is rare that they take them in sufficient numbers to meet the demand. That soles are fearfully dear is a very lamentable fact for the consumer, but their dearness does not imply any diminution of the natural supply—it only proves the existence of a demand which is in excess of the supply. According to the report of the Sea Fisheries Commission in 1865, soles in the Manchester market were selling at 3*d.* to 4*d.* per pound in 1856; in 1857 they were 6*d.* to 8*d.*; in 1859, 6*d.* to 10*d.*; in 1860, 4*d.* to 6*d.*; in 1861–2, 6*d.* to 8*d.*; in 1863 and 1864, 8*d.* to 10*d.*; in 1865, 6*d.* to 8*d.*; and now soles can rarely be brought at 1*s.* per pound—more generally they are 1*s.* 6*d.*, 1*s.* 8*d.*, 2*s.*, and even 2*s.* 6*d.* per pound. The demand for this favourite fish increases as the population increases. Railways have been largely instrumental in increasing the demand, as soles, with other fish, can now be conveyed from one end of the land to the other in a perfectly fresh state, which was not the case many years ago. However, our question does not directly bear upon that of price, but upon that of the natural supplies of the sea. Are soles diminishing in numbers around our coasts; are fewer caught now than in former years? It is not possible to answer this question, because we want published statistics from every trawling station on our coast, giving the daily capture of soles throughout the whole year, and no such statistics exist. Were we in possession of such statistics year by year, then, and then only, could we be in a position to say whether diminution is going on or not. If fewer soles are caught now generally all round our coasts with increased and more effectual appliances for capturing them, there must be a scarcer supply in those waters where they were formerly caught abundantly.

An East Coast fisherman writes in Mr. Day's last number of his work on fishing:—

"It is well known among fishermen that there is a falling off in the supply of soles and plaice to an alarming extent whatever may have been said to the contrary by smack, owners and fish-salesmen. To explain this I shall have to carry you back to the time when we first went to fish off the Sylt, about ten years ago, at which time very nearly all the ground from Horn Reef to Heligoland was covered, as it were, with shoals of small plaice, and intermixed with these plaice were a good many soles, both large and small. We have got as many as eighty baskets of small plaice and ten baskets of soles for one night when we first went there, and very nearly all the plaice would be thrown overboard; and you may be aware that they always die after they have been once on board a trawler. These fish are so small that I have counted two hundred and fifty in one basket such as we use at Grimsby. The small plaice that are brought to the London market are the largest picked out, and then the others are thrown away. Now we have fished there every summer, heaving big bags of small plaice on board, and throwing them away for the sake of the soles, till, by destroying the young brood, full-grown plaice have become very scarce. At the present time very small plaice will sell well, so that, now the soles have grown scarce off the Sylt, the small plaice, being saleable, make up; so you see they are bound to be caught unless stringent measures are taken for their preservation. You must remember that the quantity has decreased during these last few years, twenty baskets being the most you would get for a night now. My opinion of the matter is this, that as the ground from Horn Reef to Langerorg, within a less depth of twelve fathoms, is a natural nursery for young brood; if the wanton destruction of it continues as it has done, we shall soon find it extremely difficult to find even a moderate supply of full-grown plaice, but, if stopped, I have no doubt that both they and soles would be more plentiful. It is to the interest and benefit of every one in the fish trade that no

English trawlers should be permitted to fish within the above depth."

Mr. Mann, writing from Bournemouth to the *Field* in April 1882, says: "I have just weighed a sole of one ounce and a turbot of four ounces, which were exposed for sale here. They were selected from many others of like size. Sixteen pounds' weight were captured on one occasion, the largest not exceeding eight ounces. The bulk were taken in bag-shore nets, known as tucks, of small mesh, from which nothing can escape; but this form of net does not kill the fish, which ought to be at once returned to its native element." Mr. Day himself says: "It has again and again been brought prominently to notice, especially about the fishing-grounds of the North Sea, that the supply of soles taken in British waters is yearly decreasing, as evidenced by the trawlers having to go farther out to sea, that an increased number of vessels capture only an amount similar to what formerly were obtained by fewer boats manned with less hands, and likewise that the fish supplied to the markets consists of such as are smaller than used to be the case. Mr. E. Jex, of Billingsgate, remarked (January 7th, 1882): "There have been during the past year some thousands of boxes of soles in this market from Yarmouth, Lowestoft, and Ramsgate; while not more than one-fourth of the contents of each box consisted of fish that ought to have been caught, three-fourths of each box nothing but slips and tongues. When at Weston-super-Mare in 1879, some new trawling ground was tried, and the large size and quantity of these fishes that were taken amply recompensed the trawlers. But such localities are often over-fished, and soon become exhausted, and thus quantity has to be made up by those of smaller size. This is possibly what is found to occur in most places. Thus Mr. Dunn observes that his father was the first fisherman who employed a beam-trawl in Mevagissey Bay ; he captured enormous numbers of fish, so much so that he kept a record, which unfortunately has been lost. When the Plymouth trawlers first commenced their operations in new localities off the south-west coast (which was about the time the Californian gold-fields were discovered) they termed their new grounds 'California,' as illustrating the amount and value of their captures. It has been pointed out, by Mr. Epton and others, that a large fleet of smacks towing over the same ground will in a short time clear off the fish which are there. But the main cause of the diminution in the North Sea is generally asserted to be due to the numbers of undersized fish which are wantonly destroyed in shallow waters or their natural brood grounds by trawling smacks, steam trawlers, and shrimp-catchers, more especially by smacks along the German coast during the spring and summer months." ('The Fishes of Great Britain and Ireland,' pt. v., pp. 37, 38.)

Dr. Beverly R. Morris, whose name is known to naturalists by various zoological works, has written a letter in *Land and Water* (October 3, 1868) on the "Destruction of the Fry of Sole in Bridgewater Bay." He says : "Bridgewater Bay is the estuary of the river Parret, which flows into the British Channel about thirty miles below Bristol. The extent of the bay from north to south is about ten miles, its depth [width] about five miles. If a chart of the British Channel is examined, it will be seen that the whole of the ground within these limits is a succession of mud or sand flats, with a moderate depth of water ; and it is probable that there are few localities of equal extent which offer such a promise of abundant supply of flat fish, especially soles, and yet the actual take of these excellent fish is very trifling, and the fish taken are generally of small size, though of admirable quality and flavour. A full-size sole is a rarity, and we have to depend for soles of a fair size upon the South Coast fisheries, from whence a considerable supply is derived. The question naturally suggests itself, why is this? Why do not the soles in Bridgewater Bay attain the normal weight and size? This might have been a difficult question to solve; it is, however, too easily answered. The young fish is largely destroyed by the fishermen of this district. To explain this suicidal act of theirs, I must mention that almost the whole of them engage largely in the shrimp-fishery; in the prosecution of this, circular nets, ending in a pocket, called hose-nets, are fixed to stakes in the tide-way, and at low water are mostly high and dry, and whatever is in the pocket dies. These nets are left for two, and sometimes more, tides if the weather is bad, and it is not likely that anything is alive, unless perhaps some of those captured during the last tide. The bulk of the contents are shrimps, but besides these a very large number of small fry, chiefly soles and flounders, are also taken, these, being useless, are thrown on one side. Some bring them ashore, but most of the men throw them overboard. It is difficult to come at the actual amount of the young fry (generally from one to two inches long) thus destroyed, but I have heard it estimated by competent people at (if allowed to come to reasonable maturity, say from six to ten inches long), from five to eight hundred tons annually of soles alone. That such a wholesale destruction of one of our best and most nutritious fishes should be continued is a matter of very serious moment; and I trust the Government may be induced to take some decided steps with a view to legislation upon this very important matter. It seems a great pity, and indeed a disgrace to the district, that we should be dependent on the South Coast chiefly for a supply of fish, when we have at our very doors a fishing district second to none in England, as I believe, for the growth and capture of flat fish. That a paltry fishery for shrimps should be permitted to interfere with such a valuable one for soles, &c., as I am confident could be easily developed here, is a matter of deep regret, and no reasonable effort should be omitted to alter such a state of things. Some of the fishermen set as many as eighty of those hose-nets, and the constant destruction of young fry can readily be imagined. Surely some other way may be devised for taking shrimps which could not be injurious to the sole fry, and probably equally remunerative to the fishermen."

The late Mr. Frank Buckland says: "Great destruction of small soles takes place by in-shore trawling in the spring months—a matter that demands the interference of the legislature. Mr. J. L. Sealy, writing from Bridgewater, April 12, 1869, speaks of the enormous waste of fish food by the destruction of young fry. As much as eighteen cwt. of the fry of soles, plaice, herring, whiting, &c., is calculated as having been destroyed in one day."

That the destruction of young fry of various kinds of fishes is very great, there can be no reasonable doubt; and soles are not exempt from suffering in this respect. Certain statements however, such as that of Mr. Epton "that a large fleet of smacks towing over the same ground will in a short time clear off the fish which are there," must, I think, with all due respect to him, be taken *cum grano salis*. Man's destructive agency in a limited area may do, and often does, much injury; but in the wide expanse of the North Sea one cannot possibly imagine that much, if any, appreciable work of diminution goes on. The trawlers at Grimsby, though the fleet is, I believe, between 700 and 800 vessels, are widely separated; it is seldom they come near together; often many miles separate them. When I was trawling in the North Sea, in July 1882, I thought it quite a novelty in the wide abyss of waters to come near a smack at all; and when we consider the vast area of ground and the comparatively small area trawled over, there must be an abundance of fish life which is never disturbed at all, or at any rate but seldom. Take Torbay, a limited area—for a long time, year after year, have the trawlers worked there; and, if over-fishing could cause a diminution in the quantity of soles, it certainly might be expected to do so there; but, from what I could learn from the fishermen, there is no diminution; catches are confessedly uncertain; soles are erratic in their movements; the weather the last few years has been stormy, and soles have not been brought to the market in abundance sufficient to meet the demand.

With respect to the waste of young sole life in the shallower waters, all that can be said is this. It seems a pity that there should be such waste; waste in anything is a thing to be discountenanced; but waste, as we usually interpret the term, occurs in nature a thousand times more than it does by any destructive agency wrought by human hands. A storm will cast up on the shore the floating eggs of fishes, and strand them there to perish in millions; young fry are left on the beach by the retiring tide, and a hot sun kills millions in the shallow waters in an hour or two, but there is always a residue left from the shallow waters which survives and goes into deeper waters, there again to encounter in their various stages of existence the numerous enemies, whether mammal, bird, or fish, which they are sure to meet with; but even here a large percentage remains to grow up to sexually mature forms, and deposit their spawn in the shallow waters; and these again have to go through the same beneficial process of being thinned by various forces, whether living or cosmical, once more to leave a surviving progeny, destined to populate the widest areas. But it may be asked : if all this be true, what is the use of taking a lot of little fishes which are not of the smallest value—why not leave them to grow? The answer is a simple one. If by legislative interference we put a stop to catching the small fry of soles or of other fishes, we must also put a stop to the capture of a large number of adult fishes, of various species, which form part of the staple of general fish-supply ; and the result will be a diminution of fish-food in our markets, or an interference with other most important fishing business, as for instance the capture of shrimps, which requires a small mesh. Dr. Beverly Morris contrasts what he is pleased to call "the paltry fishery for shrimps" with the valuable one for soles. Is Dr. Morris unaware that the shrimp fishery is one of great magnitude, that it gives employment to hundreds of honest men, upon whose labours depends their daily bread, and the source of much excellent food to the people? Such an expression as "the paltry fishery for shrimps" must be passed over without further comment. If we cannot have soles except at the sacrifice of the real interests of others ; if we cannot add to the luxuries of the wealthy classes or to the pockets of our fishmongers except by detracting from the necessities of a class of hard-working fishermen, then *pereant soleæ, fiat justitia.* If it were possible to preserve our young soles on the shallows without injuring the callings of any class, by all means let us do so ; but practically this does not seem possible. "The produce of the sea is the property of the people in common," as the Commissioners in their Report truly and wisely say, and we ought to be jealous of any unjust interference. Let us consider for a moment what would be the result of stopping trawling for two or three months in water of a less depth than twelve fathoms. Such water, where young fish are collected in great numbers, is at times tenanted by large numbers of predaceous fishes, especially haddock, which come to feed on the smaller fishes; cod, ling, coal-fish, skate, hake, and other carnivorous fishes would have the work of destruction all to themselves unmolested, for half-grown specimens of many predaceous fishes are found in a less depth than twelve fathoms; and all these fish, which are very important commercially, would be disporting themselves in the water instead of supplying us with food. Mr. Day says any prohibition against the capture of soles under a certain size would make penal the capture of the little sole (*Solea minuta*), and he asks: "If these small forms alone are permitted to increase, what will be the effect on the food of the *Pleuronectidæ* generally? For, should the useless forms be protected, and if they live on the same diet as the useful table-sole, it appears as if such legislation might cause more injury than benefit to the fisheries." I cannot attach any force to this argument, because I do not believe that any amount of catching this kind of fish or that kind will have the slightest effect, in wide sea areas, of causing any appreciable difference in the number of fishes or in their natural food supply. These comparatively shallow waters are very productive of fish, because there is more abundance of food there; as the fish grow larger they wander far and wide into deeper water, and if we want to catch them we must go after them, and pursue them, as big fishes pursue little ones. It is of course possible, as before said, to cause diminution of soles and other fishes within limited areas by over-fishing, and if any mode of protecting the natural nurseries can be suggested that would not work injuriously to the interests of certain classes of fishermen, and would not curtail our market supplies, it is both our duty and interest to afford such protection ; but the destructive agency of fishing has no appreciable effect on the number, distribution, and food-supply of fishes in an almost unlimited area, such as the North Sea.* Professor Mobius, in his excellent Paper on the Food of Marine Animals ('Report of the U.S. Commission of Fish and Fisheries,' Washington, 1882), has well said : "In no part of the sea has fish-food decreased, as has been the case in many fresh waters of highly cultivated countries, causing a decrease of fresh-water fish. In many countries our modern civilisation has destroyed the *natural communities* (cenobitisms) of plants and animals, and substituted those plants and animals which were most profitable to man. But the natural communities of the sea human agencies can only change to a certain degree in the coast waters. In the open sea the natural communities of plants and animals will continue to live and sustain each other as long as the waves of the eternal ocean continue to roll."

The same complaints about the diminution of soles and other fishes by over-fishing, or by fishing on grounds which, as it was said, ought not to be fished at all at certain periods of the year, which are constantly made now, were made in 1863 and long before that time, and if any one who remains sceptical as to the validity of those complaints, would carefully read, mark, and inwardly digest the whole subject, so admirably, so forcibly, and so fairly discussed in the Commissioners' Report already alluded to, I think he would find it extremely difficult to refuse to attach the greatest weight to the evidence, and the conclusions based upon that most voluminous evidence, there brought so plainly forward. The daily demand for fish by the increased and ever-increasing population is almost unremitting, the daily supply is fluctuating, owing to various causes —especially, the last few years past, to the storms which on all parts of our coast have been so lamentably and destructively prevalent. In calm weather, again, though the sea may be especially productive in any given area, the supply of fish caught is often small comparatively, because the smacks have not sufficient wind to convey them to the fishing grounds, and to work the trawl when arrived there.* Moreover, after long-continued calm weather, the sea water is clear, and the fish get out of the way of the trawl. Could we always secure the best kind of weather for trawling purposes, the captures would always be great, and sometimes enormous. In the *Daily Telegraph* of April 26th, there is a paragraph headed: "Great Catch of Fish." It states that an almost unprecedented catch of fish was landed at Scarborough on the 25th. During the morning tide ten smack trawlers and one steam trawler arrived, having an average catch of 100 boxes each, or about 1100 in all. Each of these boxes, being level filled, will weigh about four and a-half stones, so that there would be landed 4950 stones weight of fish. The latter was of varied character, and sold cheap, although there was good demand. Soles were sold at about 1*s.* 4*d.* per pound—we are not told whether the catch of soles was proportionately great ; but they are always in demand, and always fetch a high price. Now it is certain that at this time of the year (end of April), soles are far from being in their best condition ; they have not recovered from spawning ; and soles, like nearly all fishes, do not eat at this time ; their flesh becomes to some extent watery and soft ; but in the eyes of the public a sole is a sole at all times of the year, and equally good. If people were wiser they would refuse to pay an exorbitant sum for a fish which at this time of the year is neither nutritious nor of much flavour. But custom and fashion rule dominant, even in matters relating to a fish diet. Codfish, which spawn early, have quite recovered by July, and are fat and in excellent condition at that time ; but fashion says oysters are not yet ready, and so fresh cod is out of season in the aristocratic world of London and elsewhere. So fresh codfish is but little consumed ; and the great quantities caught are salted and sent to foreign markets.* It is time to say a few words on the third question proposed.

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* "The well-known fishing grounds in the North Sea," as the Sea Fisheries Commissioners remark, "are even yet only partially fished. The Dogger Bank, which has an area of several hundred square miles, and is most prolific of fish, is to a great extent unworked by the trawlers, and new grounds are still being discovered where fish are found in great abundance. Between England and the Continent the average depth of the German Ocean is ninety feet. One-fifth of it is occupied by banks which are always being added to by the muddy deposits of the rivers of both countries. In extent they are equal to the superficial area of Ireland. To these banks the animals of the ocean chiefly resort, and this great and prolific field is free to the industry of all." (Report, p. xvii.)

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* The want of more steam-trawlers, either to act as carriers from the smacks or to fish themselves, is becoming more apparent.

CAN THE SOLE BE ARTIFICALLY CULTIVATED?

There is an old saying that what has been done before can be done again ; and soles have been kept alive in salt-water ponds, where they have grown and thriven ; they have also done well in fresh water. The ancient Romans kept soles, with other species of fishes, in their vivaria ; Dr.

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* Of course in the hot weather the necessity of salting the larger proportion of codfish is apparent. I am only speaking of the general opinion that the codfish is not at that time of the year eatable.

Badham, in his interesting book, 'Prose Halieutics, or Ancient and Modern Fish Tattle,' has given us a very good account of these vivaria of the ancient Romans, which I will now transcribe. I should mention that Varro (born B.C. 116) and Columella (a contemporary of Seneca, who lived at the early part of the first century of the Christian era) are the chief authorities on these Roman vivaria, though frequent mention occurs of them in the writings of Cicero, Horace, Martial and others. Columella enters much more into particulars than Varro, and gives us directions as to where and how to construct proper marine fish-ponds. "He particularly recommends them in insular situations where the soil is poor, and the returns small or none; in such situations they may be made to turn to excellent account. Mere sterility, however, ought not to be the only consideration in determining the site of a sea-pond; several other things, as we shall presently see, should also enter into the account, but, when these are present, the best place to commence operations is so near the sea that its waters may easily wash through, and never stagnate, thus imitating the great main whence they are derived, which, never being of the same temperature, is in perpetual motion, and renewed every hour! They may be made of tiles, 'opus signinum,' or be excavated in the solid rock; in either case, in all such ponds as are not perpetually motionless and asleep, that extremity which lies furthest from the sea, and is deeper and cooler than the other, should conduct by straight or tortuous channels into a grotto where the scaly troop may retire from the heat of the day, like cattle, for refreshment and cover. The watery alleys leading to these places of repose should not be too broad for *Murenæ*, which prefer a narrow nestling trough; some, however, object altogether to mixing *Murenæ* with other stock, as they are liable *to go mad, like* *dogs*, and in that case will bite, run down and destroy every other species shut up in the same reservoir, till they have entirely consumed them. In feeding these reservoirs the supplies of water should be let in from one side, and the issue, if possible, be made to take place at the one opposite; this will secure a perpetual renewal of the water, which is a matter of prime importance here; a convenient coolness being also of equal consequence for the salubrity of the fish, the deeper the source whence the sea water is procured, the better; and, whenever it is practicable, the pond should fill itself from below. When the vivarium to be formed is scarcely above the level of the sea, its basin should be dug out about nine feet, and the conduit pipes placed about two feet from the top; they should be as capacious as possible, to admit sudden flushes of water, which will help the issue of the stagnant mass lying below the sea's level . . . . In providing for the issue of the water from the pond, the exundation is best effected by means of a brass grating, with apertures of a size sufficiently great to let it run freely out, but too small to allow the escape of the young fish. If the dimensions of the pond permit, it is no bad practice to remove fragments of rock, covered with seaweed, from the neighbouring shore, and to scatter them here and there in these little enclosures, in imitation of the open sea. As the *gîtes* of the fish are very various, some lying on a sand, some ambushed in mud, others feeding amo your pond should be constructed according to the of the sea in the neighbourhood; and, finally, w work is completed, a series of stakes should be pla semi-circular form round that part of it which l water. These must be placed above the level c so closely as to break the force of the infringin to keep out the wrack and weeds which would the piscina. Having thus constructed and secured the pond against casualties, the next point should be to stock it wisely, for as on land all fields will not bear the same crops, just so is it in the vast acreage of waters ; we must not think, for instance, because we find inexhaustible supplies and multiplication of mullet [red mullet] at large in the open sea, that we shall therefore succeed with them in a pond ; on making the experiment, we shall have the mortification to learn that rarely one or two out of many thousands of these delicate fish will bear a pond life. So too there is little use imprisoning fine exotic fish, whose requirements are not well understood. Such stock may live indeed, but they will not multiply, and so are without profit. Sluggish mugils [grey mullet] and the voracious lupus [basse] should be selected as easy to rear, as also turdi [perhaps wrasse], and other saxatile fish of value. In regard to poor fish, we make," says Columella, " no mention of them, since they are neither worth the capture nor rearing ; but, as all good fish do not thrive on the same bottom, study that which is prevalent along your own shore, and according as it is stony, sandy or muddy, do you imitate these same peculiarities in your stew. An oozy bottom does best for flat fish, as soles, turbots and plaice ; such a pond, too, is the best nidus for all kinds of coquillages, oysters, scallops, &c. A sandy bottom, though not absolutely bad for flat fish, suits the open sea fish best, such as auratas, the dentex, and Punic and indigenous umbras ; while it is less congenial to the growth of shell-fish." Columella tells us that it was customary to bring fish from the sea, and turn them into lakes ; and he mentions the names of several persons who had succeeded in their experiments.

I have already mentioned that soles are fond of frequenting rivers, which they ascend for the distance of several miles ; it is also asserted that they breed in the river Arun. Yarrell quotes from McCulloch as stating that soles have been kept in Mr. Arnold's pond at Guernsey, and that they grew there in thickness twice that of fish of the same length in the sea. More experiments are required to satisfy us that the sole would thrive well in water which is entirely out of the reach of the tide, but there is strong reason to believe that it would grow and do well in fresh water. First of all, there would not be much difficulty about that all-important matter, the question of food ; the sole requires mud mixed with sand, into which in the severe weather it can bury itself, and from which it can derive living or decomposed particles of organic matter to nourish it.

In the sea the sole feeds largely on worms of various kinds, bivalve molluscs, small fishes and crustacea. Most of these it could readily obtain in ponds and rivers. The larvæ of different kinds of insects, as *Ephemera*, *Baetis*, *Sialis*, the *Phryganidæ*, *Dyticus*, &c., fresh-water ponds could supply ; crustacea, however, it would not be able to obtain in anything like the quantity or diversity that it is able to do in the sea. Numerous species of *Entomostraca* in weedy ponds, however, would not generally fail it ; *gammarus* and *asellus* would be obtainable ; bivalve molluscs, as *cyclas*, *planorbis*, small *limnei*, are generally abundant in all ponds. But I believe that the larger percentage of food the sole would obtain from the minute particles of living or decomposed matter contained in the bottom of the water. The ancient Romans fed the soles in their vivaria on various things. Columella says that flat fishes (*pisces jacentes*) require softer food than those which dwell near rocks, because they are either without teeth, and suck in their food, or swallow it entire. "Therefore," he says, "you should offer them bits of salt fish, the gills and intestines of fishes—in fact any kind of salted refuse swept from the fishmongers' shops." He also says it was usual to give soles, turbot, and brill, green figs which had been opened, broken bits of the arbutus, and the crushed fruit of the sorbus (*Pyrus domestica*). . It would be curious to ascertain how far salt fish and fruit would agree with and nourish soles; experience would decide what kinds of food are most suited to it. There would be no difficulty in transferring young soles from the sea to a long distance inland, for they are tenacious of life. I do not know whether the ova have ever been taken from any of the flat fishes and artificially impregnated; most of the fish which have been thus treated are the cod, the Spanish mackerel (*Cybium*, not *Scomber*), and the black and striped basse of the American waters, the American shad, and the herring. It is indeed not a common thing to find a sole with milt or soft roe inside it; the soles which come to our tables with roe nearly always have it hard, and I never remember eating a soft-roed sole. However, store soles are to be had abundantly on nearly all of our sandy shores, and the net of the shrimper will secure them quite uninjured.

It is doubtful whether the sole would bear a transference from its sea-water habitation to a fresh-water one, if suddenly made; those individuals which are found far up in our rivers have for a time sojourned in brackish waters, and so have gradually become accustomed to fresh water. It is true that some fishes are equally tolerant of fresh water and salt, as the eel, the salmon, the grey mullet, and the basse; a sudden change from the salt to the fresh, or *vice versâ* seems in no way to affect them.

It certainly does seem desirable, as I think it is practicable, to utilise the quantity of sole life which is taken in the shrimpers' or the stow-boats nets, and to turn the little fishes into some suitable reservoir of salt water near the sea, where fresh flushes of water could be conducted by means of pipes. In fact there is no natural history reason why fish-cultivators should not revive the old Roman custom of open vivaria, such as those spoken of by Columella and Varro.

Amongst the classic people of ancient Rome there were some among the rich who kept and stocked vivaria merely for amusement, and who lavished untold sums of money upon their construction and their inmates. With these *beati piscinarii*, "blessed fish-pond men," of whom Cicero in one of his letters contemptuously speaks, vivaria were a mania; the fishes were sacred pets, and no one ever thought of "summoning them to the dining-table."* Such a man was Hortensius, of whom Varro says that he was not only never entertained by his fish at table, but was never happy unless he was entertaining and fattening them. But the vivaria occupation was regarded generally as a trade business. Columella says that this fish-culture was not to be looked upon as a mere common affair, but as one especially praiseworthy and honourable; and he considers that, when properly conducted, such an occupation would be a source of profit to families. "For he who has bought islands or land near the sea, and cannot derive any profit from the fruits of earth on account of the sterility of the soil near the sea, may make his profit from the sea." He also gives advice to feed the fishes well, and not do like some mistaken people, give them nothing to eat, "because when you take your fish to market, its leanness will proclaim it a vivarium fish, and not one taken from the open sea."

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* "Convocandi ad jus," says Varro, with an attempt at a pun. *Jus*, besides "law," means "fish-sauce."

The cost, however, of constructing such reservoirs would doubtless be considerable, and the care and management necessary to ensure success would certainly not be without other attendant expenses, and in a commercial point of view I should imagine very few people would care to embark in such a scheme ; but as the means of carrying on scientific researches and experiments into the natural history of the sole and many other valuable food-fishes, such vivaria would prove an inestimable boon. It will be for the Piscicultural Company, lately formed under promising auspices in London, to consider how far such a system as that alluded to is practicable and likely to meet with success.

Soles are dear ; they are not at present caught in sufficient numbers and sufficiently continuously from day to day to meet the enormous demand for them, and if we wish to increase the number of soles in our markets we must multiply our fishing-boats and fishing gear, and occupy our business over a greater area of water ; and, above all, so far as London is concerned, the monopoly of one crowded market must come to an end, and local markets must be multiplied in the metropolis, so that with increased means of capture, combined with greater facilities for the reception and distribution of our sea fishery, the consumer will have a chance of obtaining such food at a far less cost than at present.

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International Fisheries Exhibition

LONDON, 1883

LINE FISHING

BY

C. M. MUNDAHL

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1883

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CONFERENCE ON TUESDAY, JUNE 26, 1883.

MR. EDWARD HENEAGE, M.P., occupied the chair.

LINE FISHING.

BY the courtesy of the promoters of this Exhibition I have been requested to read a paper on the subject of Line Fishing.

Whatever may be the imperfection of my remarks on the subject, I venture to speak to you as one who has for many years past paid some attention to the subject, and who has had a considerable range of experience, not only within the fishing grounds of the North Sea, but beyond the North Cape of Norway, on the great fishery of Finmarken, and the various other fisheries of that coast, and in another direction on those of Iceland and the Faroe Islands.

In order to avoid trespassing on the patience of my audience I have curtailed my remarks as much as possible. Very much more might be said, but then I do not claim that my paper will be exhaustive.

Line-fishing refers to the capture of fish by line and hook. It is divided into two systems :—1st, *Long-line* fishing, which implies a continuous length of line with hooks attached on smaller lines of about three feet length at intervals of about ten feet. Such a line may extend for a distance of several miles, and have upon it 5,000 or 6,000 hooks. It is secured on the ground by an anchor at each end and at intervals of about every half a mile. From the point of each of these anchors a buoy-line rises to the surface of the sea, where it is attached to a buoy. The buoy carries a flag from a staff about ten feet in height, and may be seen for a distance of two or three miles.

Hand-lining is the term used for a single line with a lead attached in order to sink it to the bottom, and from this lead two short lines, with a hook on each, are suspended. Such a line is worked by a man or boy from the vessel's deck, and as many as ten or twelve may be worked at the same time on each of the larger vessels, which are known as codmen.

Fishing by means of lines and hooks has been carried on for many centuries; mention is made of it in the Book of Isaiah, etc., but the subject of its antiquity has been treated at length in the elaborate paper read by the learned Professor at the inauguration of this series of Conferences, and it remains for me to deal with its practice in our own day.

So far as explorers have penetrated into regions far removed from the limits of civilization, wherever these are bordered by the ocean, they have found implements corresponding to our hooks and lines, and have furnished accounts which show that a considerable portion of the food supply of the untaught savage is obtained by the hook and line. Very interesting specimens of the crude fishing gear of the Esquimaux are exhibited in the United States section of this Exhibition; the hook is formed of two pieces of bone and the line is made of strips of sealskin, and although the hook is not furnished with the barb invariably found on the fish-hook of civilized people, yet I can well conceive that it is possible, where fish is plentiful, to procure a sufficiency even with a hook so clumsy.

While referring to this fact, it may be not uninteresting to notice the wide distance between civilized and uncivilized life denoted by the barb of the fish-hook. Probably centuries of use and observation lay between the first hook and the hook which by an advance of thought was furnished with a barb.

Line-fishing is carried on to a greater or less extent all round the coasts of the United Kingdom, but the most important fishing ground is found in the North Sea, and it is from this ocean that by far the larger quantity is brought to our markets.

Not only is Great Britain supplied from the rich harvest which these waters yield, but all the countries bordering on the North Sea draw their fish supply from the same locality, and carry on considerable commerce in the various kinds of fish.

Taking into account the area of the North Sea, and the number of people supplied with food from it, as well as the great variety of fish found therein, it may be regarded as the most important fishing ground in the world. Taking a line eastward from the Shetland Isles and continuing southward to the North Foreland, from shore to shore, whether on its shallows or in its depths, on its even grounds or in its caverns—which the fishermen call pits, or holes—fish of some kind or other is found in greater or less quantity. The variety consists of cod, ling, haddock, halibut, coalfish, whiting, skate : these are the principal kinds caught on line, while almost every other kind which supplies the table of rich or poor is caught in the trawl or in the drift-net.

The other large grounds are the Bank of Newfoundland, the great fisheries of Lofoden and Finmarken on the coast of Norway, and Iceland and the Faroe Islands.

So far as information can be gathered on the question, it appears that as early as the beginning of the present century the English and Scotch were already taking the greatest advantage of the fisheries of the North Sea; the Dutch were the only other people who prosecuted deep sea fishing to any extent, but these, although holding a prominent position in the line fishery of the North Sea, and notwithstanding that their method of fishing is of the very best, yet in the number and tonnage of their vessels, or in the number of men employed, they have been left far behind in the race of competition.

The French have only within the last ten years made their appearance as line-fishers in the North Sea; on the other hand they prosecute on a large scale the fisheries of Newfoundland and those of Iceland, the latter of which I shall take occasion to refer to before I conclude.

Belgium sends a few vessels to the hand-line fishing in the North Sea, but these vessels are small and inferior, and do not compare with the craft of either England or Holland engaged in the same trade. They fish for cod, most of which is salted in barrels for home consumption, and in this particular branch they certainly succeed in producing a very superior quality.

Holland, as already remarked, takes a prominent part in the line-fishing of the North Sea. Besides having a fleet of several hundred open boats and vessels of small size, which fish with lines along shore when circumstances permit, they have a fleet of some fifty vessels or more sailing from the fishing ports of Perniss, Middleharniss, Zwartewaal, Raardingen and Maasluis.

Nearly the whole of this fleet consists of vessels of a modern class, which have supplanted the old Dutch hooker of primitive shape, with its great square sail. They are constructed with wells for the keeping of the fish alive, and generally during the summer months carry ice, with which they preserve the dead fish of their cargo. They bring about one-half of their winter's catch to the English market, making Grimsby their *rendezvous* ; another considerable portion of the catch is disposed of in Belgium.

During the summer months a number of this fleet is occupied in the herring fishery, another part in the haddock fishery, and the remainder in the hand-line fishery for cod in the northern latitudes of the North Sea. At this season of the year, instead of keeping their catch alive, they salt it in barrels and land it at Vlaardingen, which is the great Dutch market for this article. From this place it is distributed, partly to other Dutch markets, but chiefly to Belgium.

Germany does not put in an appearance at all on the high seas. I am aware that small fleets of fishing boats sail from Blankensee, principally, and from other points down to Cuxhaven on the Elbe, and a few from the rivers Weser and Jahde, but they seldom venture beyond Heligoland Deep, and indeed few of them, if any, come within the branch of line-fishing.

It is a matter of surprise, and one that may be worthy the notice of His Excellency the German Ambassador, who appears to take an active interest in the present Exhibition, that so great a nation as Germany, and a people so energetic in all commercial life, should prefer to go abroad for a considerable portion of their fish supply, when they might profitably occupy in the trade a considerable number of the population, and by such means become their own purveyors.

Denmark finds a supply of fish along the shores of Jutland, in the Kattegat and the Belts ; their line-fishing is confined to these waters, and is prosecuted with vessels of small tonnage and by open boats. They make no attempts to supply other nations, and on the other hand they do not need to purchase to any great extent from abroad.

Sweden sends a large fleet of fishing vessels to the line-fishing in the North Sea. Their vessels are not attractive in appearance ; having a keel short in proportion to the length over all, they present a rather unsightly picture, but are constructed with a view of riding at anchor in the open sea. They are probably the best model for such a purpose.

They are usually manned with twelve hands. The vessels are mostly laid up during the winter months from November to March, and for the rest of the year they are occupied principally in long-line fishing between the latitudes of 57° and 63° N. They carry on their operations along the edge of the great bank which runs along the deep-water channel fronting the Norwegian coast, and is commonly known as the Reef; but several of them have of late years moved westwardly to within fifty miles of the north of Scotland.

Their practice is to place their lines on sloping ground, from a less to a greater depth of the sea, sometimes to as much as 200 fathoms, a depth so considerable that almost all other fishermen shrink from the severe labour entailed in hauling them in again. The hardy Swede, however, appears to take it all as a matter of course, and is frequently rewarded for his toil by immense catches of ling and other kinds of fish.

I am informed on reliable authority that as many as a thousand ling have been taken in one day; reckoning a ling at an average of 24 lbs. this represents nearly 10½ tons of ling, besides cod and other kinds of fish, of which they catch a fair proportion. These quantities are perhaps not equalled by any fishermen in the North Sea, and can only be approached in their quantity by the Norwegian fishermen at the great periodical fisheries of Lofoden, Finmarken, and Romsdal.

The bait used by the Swedish fishermen is in the first instance the mussel. With these they bait their haddock line, which they work on banks adjacent to their great fishing grounds, where the haddock is found in large quantities; after a day's catch of haddock they sail away into deeper waters, and then in its turn the shiny haddock is cut up to make bait for the ling and cod, so carrying out the great law of the survival of the fittest.

A specialty of the Swedish fishing lines is the float used on the snood. This is made of cedar bark cut to shape, about three inches long by one inch in diameter, and boiled in beeswax in order to render it impervious to water; it is so attached with respect to the hook as to keep the latter about two feet from the ground. Like the swinging signboard of a country inn, it makes a display which the hungry traveller cannot well resist, and as a consequence it is readily snapped at. It also serves the purpose of keeping the bait off the dirty ground and above the reach of the star-fish and creeping insects which infest large portions of the bottom of the sea.

The position held by Norwegian fisheries is by far the most important both as regards the number of persons employed and the quantities landed. But inasmuch as their great fisheries are localised and carried on within the limits of their own coasts, and as they have been already referred to by Professor Huxley, I will only briefly notice them.

Their boats are almost exclusively open, and of a small size compared with the usual fishing vessel for the open sea. Their lines and hooks are about the same as those used by our own smacks, the principle of working them is also nearly the same, with this exception, that whereas the immense shoals of cod on their journey to the coast do not always take the ground—as the term is—but move at a greater or less depth, they ascertain the position of the fish in the sea, and then instead of sinking their line to the bottom they suspend it in mid-water by means of glass globes which they attach to their line. Specimens of these glass globes may be seen in the splendid collection of the Norwegian department. I am not aware that this system is used by any other fishermen, but it recommends itself as a very ingenious and successful method, and as a proof of its utility I may remark that instances have come under my notice in which on a line of 3000 hooks, so suspended, 2000 fish have been taken in one haul, while neighbouring boats whose lines have been set at a greater depth have drawn almost a blank.

Some attempts have been made of late years by the Norwegians to take a part in the open sea fisheries, and I regret to say they have not been so successful as they deserve. I venture, however, to express the opinion that as a people they possess too much energy and enterprise to be baffled by a few fruitless attempts, and that by perseverance they will succeed. A people so hardy, and by constant practice so inured to the hardships and dangers of the sea, is eminently qualified to take a prominent position in this direction. Having so far briefly considered the position of our friends and neighbours as regards the subject of my address I will pass on to notice our home line-fishing.

I have already referred to the fact that line-fishing is carried on more or less all round our coast. There is scarcely a village or a hamlet on the east coast of England and Scotland without its fishermen. The beach boat, yawl, coble and other open boats that venture out from along the English and Scotch coasts when weather and other circumstances permit, to work their lines, may be counted by hundreds. But, as His Royal Highness the Duke of Edinburgh has remarked in his admirable paper, "the term fisherman is a somewhat elastic one," and the occupations of persons who style themselves fishermen are of such varied character that we must leave these in order to deal with that class whose sole occupation is fishing and who make this calling the business of their life.

Before the railway system had grown to anything like its present proportion the small town of Barking in Essex was the great fishing centre of England. Being near to London and on the Thames its situation was a most convenient one for the fishermen who made it their business to supply the Metropolis with fish. Nearly fifty years ago a fleet of about 200 decked vessels sailed from this place, and the trade was considerably developed as regards the size and construction of their vessels and the efficiency of the men themselves. Still their smacks were small compared with those of the present day ; most of them were under forty tons register. These vessels were adapted both for lining and trawling, and were alternately occupied in each trade. The remainder of the lining fleet was made up from Greenwich, Harwich, Gravesend, Aldborough, Blackwall and Deptford. They used to go to the Dogger Bank during the winter months, and worked with long-lines ; during the summer months some of them fished with hand-lines on the north coast of Scotland, some of them were occupied in carrying lobsters from Norway and Sweden to the London market, and others were engaged in the whiting and haddock fishing. They all used to bring their live cargoes to Gravesend and thence sent them forward from day to day to Billingsgate market.

In the year 1851 the Manchester, Sheffield and Lincolnshire Railway Company had completed their magnificent new docks and line at Grimsby; and the direct connection established by this rail with London and the great provincial centres, together with the geographical position of the port with regard to the great fishing banks, recommended it as the most convenient fishing centre on the east coast.

Smack owners from Harwich, Greenwich and Barking commenced to send their vessels here periodically; a company in connection with the Manchester, Sheffield, and Lincolnshire Railway Company was formed, and for some years employed twelve smacks—one half the number in the lining, and the other half in the trawling business. A market and a dock for the special use of the fish trade were constructed in 1855; and so rapid has been the growth of the trade from that time to the present day that the efforts of the railway company in extending the dock accommodation have hardly been able to keep pace with the increasing trade.

I have not been able strictly to arrive at the relative figures of tonnage, but I shall not be far from the fact, and perhaps near enough for the purpose of this paper, if I compute the tonnage of all fishing vessels in Grimsby in 1855 at 800 tons, half of which were cod smacks. At present the tonnage actually belonging to the port is not far short of 40,000, 8000 tons of which is represented by about 120 cod smacks, while most of the cod vessels from Greenwich, Harwich, and also from Holland, trade here regularly during the long-line season. The population of Grimsby has during the same period increased from 10,000 to about 40,000.

This great development of the line-fishing at Grimsby has not been without its effect on the other fishing towns which I have named. Barking and some of the other places referred to have retired from the trade altogether, and Greenwich and Harwich are now the only other places from which cod vessels take part in the line-fishing, and that only to a small extent.

A number of yawls or luggers from Filey, Scarborough, Hartlepool, and the Tyne, engage in deep sea lining during the spring of the year, but they are not vessels with wells, and can only be said to be partly engaged in the trade.

A cod smack is a fore-and-aft dandy rigged vessel, with foremast and mizen-mast. Those built of late years vary from seventy to eighty-five tons, and we have some of over 120 tons register. The usual dimensions are sixty-five to seventy feet length of keel, twenty to twenty-one feet beam, and eleven feet to eleven feet six inches depth amid-ships; in ordinary ballast trim they draw about eleven feet of water aft, and from seven to seven and a half feet forward. They are as a rule fast sailers, and their seagoing qualities cannot be surpassed. I make no doubt that Christopher Columbus and Captain Cook would have rejoiced to have had such vessels for their expeditions. They are built principally of oak, and fitted with cabin and forcastle; the master and five men occupy the cabin, and four to six boys the forecastle.

In the centre of the vessel a space of nearly one third of the length of the keel is set apart for the well; this is divided off by strong bulkheads, or well-heads as they are termed, of oak twelve to fourteen inches thick; the space so set apart is again divided by one or two sectional bulkheads, thus forming two or three wells, as the case may be. These well-heads are carried upwards for about half the entire height of the vessel, or about five feet six inches, a strong oak deck is then laid over all from the fore to the aft well-head, forming what in a merchant ship would be called 'tween decks, and on board smacks is styled a well deck. From the centre of the well deck a strongly encased watertight hatchway called a well funnel rises to the upper deck. The bottom of the well is planked over in the same way as the rest of the vessel outside, in the planks well-holes are bored about fifteen inches apart, and through these the water is admitted into the well, and by the motion of the vessel when at sea is freely circulated. Above the well deck and in the after part of the vessel's hold, the space is used for an ice room, where about eight tons of ice is stowed, and compartments made for the stowage of the fish which die on the voyage. The fore part of the vessel's hold is used for spare sails and the fishing gear. The smack carries with it a boat about twenty feet in length, six feet four inches in width, and three feet in depth. Very frequently this boat is used for hauling the lines at sea, and when the winter gales carry destruction to the ships in the North Sea, the English fisherman is never slow in launching his boat and risking his own life in order to save his fellow. Never a winter goes by without numerous instances of this kind taking place, in many cases without reward or even notice being bestowed, in others they are duly acknowledged.

The bait formerly used by the codmen was whelks, but for the last twelve years this has been varied with lampreys and herrings, when obtainable, according to the season of the year, and the fishing grounds where their operations have been carried on. During the summer months, whelks and herrings are now used, and from October to April, lampreys and whelks by the vessels that go to the Dogger and the Great Fishery Banks, but whelks only by the vessels that fish on the grounds nearer home.

The cost of bait is a considerable item in the outfit of a cod smack, amounting to from twelve to twenty pounds per voyage. Ice is another item, which may be put as from seven pounds to ten pounds per voyage, and these, together with wages and food for the crew, harbour dues and other requirements, bring the current expenses of a smack up to about thirty pounds weekly, without any allowance for wear and tear, insurance or interest on capital invested.

The vessels are insured in local mutual insurance societies against total and partial loss up to a sum representing from one half to two-thirds of their value, and the yearly cost of assurance seldom exceeds two and a half per cent. of amount assured. A smack such as I have described of about eighty tons register costs ready for sea from £1,600 to £1,800.

Previous to 1862 the long-line operations never extended beyond the Dogger Bank. But since then they have year after year been carried further northerly and easterly, and at the present time the whole area from Shetland southwards is fished upon.

As soon as the vessel arrives on the fishing ground, the lines are got ready, and the hooks baited. Where whelks are used as bait, the shells are broken with a mallet, the snail is sorted out, and carefully put on the hook. If lamprey or herrings are used, they are cut into small slices and so put on the hook. A curious fact with regard to this kind of bait is, that cod, haddock, or ling will seldom or ever accept the tail-piece of either lamprey or herring. The skate however is not so particular with regard to the joint.

The lines are coiled into a tray made of wood, usually 480 fathoms in each, and the hooks are placed with careful regularity in rows on the bottom of the tray. About two or three hours before sunrise the lines are laid out. The end of the line is attached to an anchor, which is secured to a buoy-line and buoy, the vessel is steered away, usually to the wind or close hauled, and one of the men "pays out" or "shoots" the line, as it is termed, while the rest attend to the anchors and buoys. When the whole length of line is out, it is allowed to remain two or three hours, and then the hauling commences. As soon as a cod or ling is caught it is carefully pierced under the fin on the right side, in order that the air with which the belly of the fish is inflated may escape. This operation, which is carried out in less time than I have used to relate it, being performed, the fish is dropped into the well. The cod and haddock are usually allowed to swim about free, the ling and halibut are suspended by their tails, and so confined they are found to live longer.

A day's catch may vary from twenty cod or even less, to three or four hundred cod and ling, and proportionate quantities of haddock and other fish. The vessel usually returns to port after an absence of from eight to twenty days; on its arrival the live fish are put into chests or trunks, which are kept afloat in the dock and adapted so that the water may circulate freely from without. The dead fish are landed in the market, and it is sold at once, being forwarded thence to all parts of England, Scotland, and even to Ireland.

During the summer months the greater number of the vessels go to the codfishing at Iceland and the Faroe Islands, where they fish with hand-lines. The fish caught here is salted during the first part of the voyage, and the fish so salted is generally sold to merchants in Shetland, who dry it and export it to the Spanish, Scotch, and Irish markets. During the latter part of this voyage they keep the best of their catch alive, and bring this proportion home at the close of their voyage.

I mentioned in the early part of my remarks that the French sent a considerable fleet to the Iceland fishery, and I wish to draw attention to the fact that the French Government send with this fishing fleet a corvette and a gunboat, whose duty it is to superintend and assist, and give *prestige* to their fishermen in those parts. Considering the number of British lives and the amount of British property employed in the same direction I venture to think that if our Government could be induced to send one of their smaller vessels of war to this coast during the fishing season it would be an act of service to British interests.

There is only one other point to which I beg to call your attention. On the nearest banks and along the shore of the east coast a large quantity of immature cod are caught, and I firmly believe, notwithstanding what we have heard from Professor Huxley on the subject, that this wholesale capture of the young will sooner or later affect our supply of cod on the home grounds.

My proposal is, that a law similar to that which protects the crab and the lobster should extend to all kinds of immature fish so far as it is possible to carry it out, and as the Board of Trade is very anxious to do something for the fishing trade, I would very respectfully suggest that it should take the young fish under its care, and establish one or more stations for the culture of those kinds of sea-fish which form such important part of the food supply of the nation.

DISCUSSION.

Sir Edward Watkin proposed a vote of thanks to Mr. Mundahl for his very able paper. He said he did not do so as a mere matter of compliment, but because the paper really contained a great deal of instruction and information on a most interesting question. With regard to one of his remarks as to the course which the French Government had taken with regard to protecting and keeping order on the fishing grounds where French vessels were occupied, he must say that he had often wondered, seeing that Englishmen were more dependent on fishing than any other country, that our Government should have taken so little care to protect and keep order on the fishing grounds where our fishermen were employed. He could only explain the reason of the apparent indifference which was shown, by the fact that in many public departments the people who had to do the executive work were excessively ignorant. He did not know whether any one else present had been struck with it, and perhaps it would be rather out of order for him to make such a remark, but in this country we seemed to be getting every day more and more infested by those ignorant people who were always anxious to get official pay and employment. He had no doubt now that Mr. Mundahl had called attention to this matter, and that, generally speaking, owing to this Exhibition, public attention was being concentrated on the important question of our fisheries, there would be a little more courtesy and attention shown on the part of the Government, and that encouragement which the flag of England always gave would be afforded to those industrious men who risked their lives in an important and interesting calling, and that it would be found that some of our gunboats would be placed on important fishing grounds as a regular institution of the future. Mr. Mundahl had explained in the most graphic and interesting language the whole operation of line fishing, and no doubt there were many things which would be eminently suggestive to those who had listened to the paper. He had certainly taught him a great deal ; and no doubt every one, although they might be acquainted with the subject, would learn something. It was not always, even in these interesting discussions, that everything useful was to be learned, and nothing which had a contrary tendency ; he did not know whether it was the fault of the reporters, but he read the other day in the *Times* that at one of the previous Conferences it was laid down as a fact that the fishermen were a class of persons so very improvident and so very poor that they were always in debt. Whether that was so in other parts of the country he could not say, but with regard to the two great fishing districts he had been acquainted with, viz., Great Yarmouth and Grimsby, he did not think there was a more provident, saving, and God-fearing class all round than the fishermen of those two places, and he decidedly objected to its being put forward that they were so improvident that all the year round they must be in debt. Again, they were told on eminent authority that these men ought to put their money into saving banks and things of that kind, and ought never to enter into speculation by putting their money into the fishing industry with which they were connected. Now, his opinion was that the man who was connected with any industry which he liked, which he conducted with success, and which was the occupation of his life, could not do better than invest his savings in that industry. He was afraid that he had rather digressed from the first line of proposing a vote of thanks to Mr. Mundahl, but he could not help making these observations. The Chairman, the Hon. Member for Grimsby, and himself, with a number of others, were members of a Select Committee to consider the question of harbours, and that day before coming to the meeting he put a question to Mr. Stephenson, one of the most eminent of the Scotch engineers who built the harbours and lighthouses round the coast of Scotland, saying they had been told by Sir Thomas Boyd that since the improvement of the harbours of Scotland during the last forty years the fishing trade had doubled, and further that if they could only provide proper harbours round the Scotch coast the extension of the fishing industry was illimitable, and asked Mr. Stephenson his opinion upon it. His reply was, "Well, illimitable is a large word, but I do not think it is extreme. I think the whole question of the extension of fisheries in Scotland is a question of the improvement of harbours." Now, if that were so they knew exactly what was required, and he was quite certain that in that Committee they would have the candid support of the Honourable Members for Grimsby in favour of improving the harbours of England, Scotland, and Ireland as far and as fast as they could, with the view of improving this noble industry of fishing. There was only one other point he wished to mention, and that was this—it was not merely a question of catching fish, it was a question of the naval supremacy of this country, for if the fishing interest were abolished to-day where would be the navy the day after; if on the other hand by a judicious outlay of capital, everybody pulling together, and dropping all that nonsense about private enterprise, they could bring the force of opinion to bear in favour of the construction of great public works all round the coast, they would not only be securing a large increase of the fishing industry, but would also be increasing the supply of that grand human raw material which would defend our coasts against any enemy, and secure for ever the supremacy of England on the sea.

Mr. BIRKBECK, M.P., had great pleasure in seconding the motion. It was most gratifying to the Executive Committee that they had been so fortunate in the selection of the gentleman who had just read the paper on this very important industry, and felt sure that when the ultimate result of the Exhibition was collected, as he hoped it would be in a very formidable blue book, this paper would appear in it, and prove of very great interest. Personally he took great interest in this question, because from his boyhood upwards he had been over these very grounds to which Mr. Mundahl had referred, and perhaps even further; he had been up as far as Spitzbergen and seen shark fishing there. One of the most amusing incidents in connection with that fishing was this. When the smacks about the size Mr. Mundahl had referred to had commenced their fishing, sport was very bad for the first few days, because they had to get rid of the smaller sharks, and, rather than throw them overboard and let them sink down for the larger sharks to feed upon, they adopted the very ingenious plan of taking out their livers, introducing a pair of bellows, and, sewing up the shark's belly, let the fish float away with the tide, so that the larger sharks they wanted to catch would not prey on the smaller ones. He felt confident when this question of line fisheries was more prominently brought before the country that the application of capital to far more distant grounds would follow, and in that way the supply of fish would be largely increased. He begged to thank Mr. Mundahl on behalf of the Committee for his most excellent paper.

The CHAIRMAN, in putting the vote of thanks, said he naturally took the very greatest interest in the paper, not only for its own value, but on account of the gentleman who had read it, for being so essentially connected with Grimsby, everything to do with fishing and those engaged in it must have the deepest interest for him. He could not attempt to compete with the gentlemen who had already spoken in their knowledge of this subject. Sir Edward Watkin had, perhaps, in railway enterprise done more for fishing than any man living, the proof of which was shown by the statement given in the paper of the position of Grimsby with regard to fishing some twenty or thirty years ago compared with what it was now. If any further proof were required he would recommend any one to read the very excellent report of the Committee which sat last year on the condition of fishing lads and others engaged in the trade in England and Scotland. He entirely agreed with what had fallen from Sir Edward Watkin and Mr. Mundahl with regard to the way in which the fishing interest was neglected by public departments. He thought it was a disgrace that we had not with our large fleets a man-of-war or gunboat always at hand, not only to be a protection to boats when fishing, but also to be there ready to give assistance when those sudden squalls or gales came on which had done so much to make widows and orphans during the last two or three years. If a gunboat or a man-of-war had been on the spot in March last they would not now have been required to raise a large fund for the widows and orphans of Hull and Grimsby, which he regretted to say they were obliged to do now; at the same time he hoped that all would generously contribute to the relief of that which was almost a national calamity. With regard to what had been said by a learned gentleman in one of the previous papers as to the improvident character of fishermen, he ventured to say that facts entirely contradicted the statement. The matter came before him when working with the Board of Trade Committee, that a very large proportion indeed of those who entered as apprentices or seamen into this work rose to be some of the largest smack owners in England, and that being so, it could not be said that there was such great improvidence. They knew that in all classes there was improvidence, but why this fault should be charged upon fishermen in particular he had never been able to understand.

Earl DUCIE then moved a vote of thanks to the Chairman.

Mr. MUNDAHL said it afforded him very great pleasure to second the resolution. As a Grimsby man who had the honour of being represented by Mr. Heneage, it always gave him, as it did a large proportion of the Grimsby people, great pleasure to meet Mr. Heneage, because he was always so ready and willing to do anything he could for the benefit either of the fishing interest or the general interests of the town. Before sitting down he would take the liberty of saying, in response to the vote of thanks which had been passed, that the requests of the energetic and able Chairman of the Exhibition were always made with such geniality and courtesy that it afforded every one great pleasure at all times to comply with them. Personally he felt indebted to Mr. Birkbeck for the part he had taken in arranging this Exhibition. He had the greatest hope as to the fruits of it, and he was sure the nation would forget itself if it did not in some substantial way recognise the services of Mr. Birkbeck.

(The vote of thanks was carried unanimously, and briefly acknowledged by the Chairman.)

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International Fisheries Exhibition

LONDON, 1883

MOLLUSCS, MUSSELS, WHELKS, ETC.

USED FOR FOOD OR BAIT

BY

MR. CHARLES HARDING

(OF KING'S LYNN)

LONDON
WILLIAM CLOWES AND SONS, LIMITED
INTERNATIONAL FISHERIES EXHIBITION
AND 13 CHARING CROSS, S.W.
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THURSDAY AFTERNOON, JUNE 21ST, 1883.

THE Chair was taken at 2 o'clock by Mr. TYSSEN-AMHERST, M.P., who briefly introduced Mr. CHARLES HARDING, of King's Lynn, to the Congress.

MOLLUSCS, MUSSELS, WHELKS, ETC., USED FOR FOOD OR BAIT.

Whelks.—The Lynn fishery supplies about 20,000 bags, or 1,250 tons of Whelks a year, nearly all of which are used for human food. The average amount paid for them before the expense of boiling and carriage is about £10,000.

Whelks are caught in whelk-pots, which are small round baskets about 1 foot in diameter, with a hole in the top, through which the Whelk crawls, and is unable to return. These pots are sunk in from 5 to 30 fathoms of water, and baited with Crabs, Haddocks, and other fish.

The following places are the principal sources of supply:—Saltfleet, about 20 miles from Grimsby; Sherringham, by Cromer; Lynn Deeps, Docking Channel, Blakeney Coast, Wells, Boston Deeps, Brancaster, Thornham, and Hunstanton.

The Great Grimsby fishery supplies about 150,000 wash of Whelks annually. A wash contains 21 quarts and a pint, and the average price for the season would run about 3*s*. a wash, or a total of £22,500.

It is supposed that out of the 150,000 wash caught, not more than 6,000 wash are eaten ; the other 144,000 are used for bait by vessels engaged in catching Cod, Ling, and Haddocks, each vessel using on an average voyage 45 wash, which in fine weather they would use in four days. The Grimsby smacks engaged in catching Whelks are fitted with wells, into which the Whelks are put after being first placed in nets ; by this means they are kept alive, as they are almost useless for bait when dead.

The vessels used in catching Whelks are from 15 to 30 tons register, and some of the better ones cost from £600 to £700 each.

Most of the Whelks caught by Lynn smacks are sent to London for human food.

The edible Whelk is considered a very nutritious and strengthening food, and is always free from poisonous matter. I have heard fishermen say that a dish of Whelks does them as much good as a beefsteak.

I am indebted to Mr. D. Barnard, of Lynn, and Mr. W. G. Marshall, of Great Grimsby, for the above statistics concerning the Whelk.

I consider the only legislation necessary for the protection of Whelks is that the fishermen should return to the sea all Whelks less than 1¾ inch in length.

Mussels.—The most important mollusc, both for food and bait, is the Mussel.

In British waters, spatting usually takes place in the spring, and does not appear to be at all dependent on warm weather. On December 7th, 1877, I examined some of the embryo taken from a spatting Mussel with a microscope, and found it to have a reddish appearance, and about the five-hundredth part of an inch in diameter. It would not polarize, so I conclude the shell was not formed.

On the 12th December, 1879, I found large quantities of Mussels to contain similar embryos, the weather at the time being very severe. On December 3rd, 1880, I found the same. The winters of 1879-80 and 1880-1 were exceptionally cold, so that it appears they are not dependent on "heat and tranquillity" for their proper development.

On the 25th of May, 1879, after a very severe winter of about nine weeks' continuous frost, I found on one of the beds under my charge several acres of brood Mussels, about the tenth of an inch in length. In the spring of the year 1879, and the spring of 1880, overwhelming quantities of brood were found on the scalps on the east coast of England, which might be measured by hundreds of acres. There has not been a fall of spat since.

I found a few Mussels containing spat this year as late as the 3rd June; they appear to spat every year, but the spat does not always attach itself to the beds. It is probably carried away by the tides.

Where Mussel brood is found in thick and dense masses, they will be three years before they are what is called sizeable, that is, two inches in length; but instances are found near low-water mark where a few have become isolated, and have grown much more rapidly.

I do not think that Mussels will spat, or rather that the spat will mature, in partially-salt water. The only places where I have ever seen any young brood is where the water has the same degree of saltness as the outside sea, which on the east coast of England has a density of about 1026½; distilled water being 1000. Although it appears that salt water is necessary at their birth, brackish water is better adapted for fattening and growing, provided they are covered with the tide at high water. I find by experience that the most suitable degree of saltness of the water for fattening purposes is where the density of the water is about 1014. This likewise applies to the fattening of Oysters.

To save the bulk of the spat when free is the great object of Mussel culture ; therefore it is imperative to have the ground of the natural sea bed as free from sand, weeds, and mud as possible, so that the young may have some clean hard substance to which it can attach itself. Ascidians and sponges are very destructive to the young Mussel, as they cover the culch, which would otherwise be favourable for their attachment.

Mussels have a great many natural enemies, amongst which may be mentioned the Star-fish or Five-finger, the Dog-whelk (*Purpura lapillus*), the Sea Urchin or Echinus, sea birds, Danish crows, and sometimes rats ; but Star-fish deal the most wholesale destruction. I have known ten acres of a thickly-covered scalp to be almost denuded in a fortnight. Last summer I had carted from beds under my control between two and three hundred tons of this fish. The Star-fish will always attack small Mussels in preference to those of larger growth. It first grasps the Mussel with its five fingers, and when it opens slightly to breathe and feed, it inserts its stomach, or part of it, into the body of the Mussel, when I believe digestion commences, and the Mussel dies and opens its shell, and the Star-fish withdraws its stomach with the meat of the Mussel. This operation I have seen performed in all its stages thousands of times, upon Oysters, Mussels, and Cockles.

The Dog-whelk bores a hole in the shell of the Mussel, about the size of a small pin-head, and destroys it.

The Sea Urchin also bores a hole in the shell of the Mussel, but much larger than the Dog-whelk, the hole being about the size of a sixpence. This very rarely occurs. I have only seen three instances, and that on large Mussels near low-water mark.

Sea birds, Danish crows, and rats break the shell and devour the Mussel.

I consider the best and only way that existing natural Mussel beds can be properly cultivated and protected, is to make them the actual property of some one. If they are allowed to be fished indiscriminately, they will quickly become exhausted, as has been the case with hundreds of natural scalps on the coast.

Fifty years ago Mussels were very prolific on the East Coast of England, and almost every small harbour had its natural scalp outside, which fed the "lays" or fattening grounds inside, to the great profit of the owners of such lays. About that period some ill-starred individual discovered they were valuable for manure, when commenced a raid on the scalps, which is the origin of their present downfall. I can remember, as a boy, seeing hundreds and thousands of tons brought to land and sold to the farmers for manure, at three-halfpence a bushel.

An Act was passed by Parliament in 1868, called "The Sea Fisheries Act, 1868," which enables the Board of Trade to grant provisional orders to corporations and private individuals to regulate Oyster and Mussel fisheries; but the result, so far, has been very unsatisfactory. The reports of Mr. H. Cholmondeley Pennell, and Mr. W. E. Hall, two of the Inspectors of Fisheries, on the Oyster and Mussel fisheries, at eighteen different stations, show the beds to be worked in a very unsatisfactory manner.

Mr. Hall reports in 1877, that the Boston Corporation undertook to regulate the fishing in Boston Deeps in the year 1870, so as to maintain the supply. The Oyster beds, he states, remain in the state of denudation which characterised them in 1869. The supply of Mussels, however, seems to be rapidly diminishing, from the persistent poaching of the fishermen, and from want of power of the Corporation under their "order" to close a sufficient portion of the ground every year. A similar "order" was granted to the Corporation of King's Lynn, in 1872. Mr. Hall reports on this "order" that the Corporation system of management in regard to Mussels is dangerous to the permanent welfare of the fishery; whilst as regards Oysters, the order is not carried into effect.

Under clause 4 of the order, the Corporation is compelled to keep open for fishing two-thirds of the area of the Oyster and Mussel beds, thus leaving a large proportion of the whole in a great measure at the mercy of the fishermen; and Mr. Hall justly points out the danger the Mussel beds of the Wash are necessarily exposed to from this provision.

When a Mussel bed is opened by either of the abovementioned Corporations, a day is fixed, and duly advertised, and at 12 o'clock at night, scores of boats commence taking the Mussels, some by tons, and some only by a few bushels. The next day the markets are glutted with small Mussels, and in some instances I have known them to be unsaleable. Even at the best they only make very small prices; whereas, if they had been gradually sent to the various markets, good prices would have been made.

I am the lessee of about eleven miles of sea-beach on the Norfolk Coast, belonging to Hamon Le Strange, Esq., whose title to the proprietary right descends from a grant made in the eleventh century by William II. to William d' Albini, his butler.

The fishing on this beach consists of Mussels, Cockles, Clams, Winkles, and a few Oysters.

When I hired the fishing, eight years ago, there was not one ton of Mussels on the whole eleven miles. I appointed watchers, enforced a close time, cleaned the ground, and endeavoured to keep off poachers, but with very indifferent success. Mr. Le Strange, in 1879, applied to the Board of Trade for the grant of an order for the establishment and maintenance of a joint Oyster and Mussel fishery, under the powers of "The Sea Fisheries Act, 1868," so as to provide a better protection for the fishery. The Board of Trade sent an inspector down to hold an enquiry as to the proposed order, and in June this year the order received the Royal assent, rather more than four years after the first application, at a cost of several hundred pounds, owing to the Board of Trade refusing to define the boundary of an adjacent fishery to which they had previously granted an order.

This order will greatly benefit the long-line fishermen off the coasts of Northumberland and the South of Scotland, as I have special railway rates to all the ports on these coasts, and can afford, when I have any Mussels, to deliver them at a reasonable price for bait. The importance of Mussels for bait to these deep-sea line boats is incalculable.

Mr. P. Wilson, late Her Majesty's Fishery Officer at Eyemouth, in Scotland, reports that in one week the boats from Burnmouth, Coldingham and Eyemouth used for baiting their long lines, sixty-one tons of Mussels. They landed, with this quantity of Mussels, 25,620 stone of Haddocks, besides a considerable quantity of Cod and Whiting, and got for the fish 1*s.* 8*d.* per stone, equal to about £2,500. Observe, in one week alone, sixty-one tons of Mussels were used at these three fishing-stations for bait, the cost of which was about £160, the produce in fish from which was 25,620 stone, worth £2,500. Mr. Wilson also reports that when the fishermen are unable to obtain Mussels, they have had to bait their lines in many instances with bullock's liver, and be content with half a catch of fish.

The greatest trouble I have in protecting my Mussel beds is from a class of men who call themselves fishermen, but who are half farm labourers and half fish hawkers, and are the scum of the villages bordering on the coast. I have lost from two to three thousand tons of Mussels in one year by these men, which would otherwise have gone to Scotland to be used as bait by real fishermen. All of this might have been prevented had the Board of Trade granted a provisional order for this fishery when requested. Taking Mr. Wilson's figures, that sixty-one tons of Mussels will catch £2,500 worth of Haddocks, Cod, and Whiting, one thousand tons of Mussels would catch about £41,000 worth of fish.

Mr. John Doull, who succeeded Mr. Peter Wilson as Her Majesty's Inspector of Fisheries at Eyemouth, writes to me on the 31st of May last as under:—

"I am not aware of any of the fishermen in this quarter using Whelks as bait. At some places on this coast Whelks are gathered and despatched to inland towns for food.

"Limpets are, however, collected in large quantities, and used by our fishermen on their lines along with Mussels.

"Fishermen inform me that Mussels will keep alive for three hours in water after they are taken out of the shell, but speedily die when placed on the hook.

"To increase the supply of Mussels, I think that leases of suitable portions of foreshores should be granted to persons who may be desirous of cultivating Mussels thereon, for which no rent should be charged until it would be seen whether the venture would be successful.

"The cultivation of the Mussels to be subject to the supervision of a Government Inspector, to see that it is properly attended to.

"The supply of Mussels to our line fishermen is of vital importance to them. For instance, here in Eyemouth alone, where twenty-eight boats, manned by seven men each, prosecuted the line fishing for Haddock from October last until now, no less than 920 tons of Mussels were used by them in that period, costing nearly £1,800 to the fishermen, about one-half of which sum was expended on the carriage of the Mussels.

"These twenty-eight boats grossed on an average for the season upwards of £600 each, still the item of Mussels bulked largely in their expenditure.

"The 28 Eyemouth boats shot their lines 2825 times during the fishing season ended May 1883; each boat carries 7 men and 7 lines, but on Mondays 10½ lines; each line is 1200 yards long, so that the total length of lines that passed through the fishermen's hands during the season was 15,200 miles, or a length that would extend to about two-thirds the circumference of the earth.

"Every day the boats proceeded to sea they shot 135 miles of lines, and on Mondays 202 miles. On each line there are 1050 hooks, and every time the boats were at sea 205,800 hooks, baited with 411,600 Mussels, were put into the sea. The total number of Mussels used during the season, averaging two for each hook, was 46,819,500: exclusive of this enormous quantity of Mussels a good deal of Limpets were used, and also some bullock's liver. Nearly all the Mussels come from the Wash or the

Boston Deeps; a very insignificant portion was from Newhaven and Ireland.

"No better fishermen than the Eyemouth men are to be found anywhere; they are noted for their industry, perseverance, and energy, and I certainly do not know of more hardworking fishermen on the Scotch coast than those of Eyemouth.

"The white fishing trade seems to be undergoing a great revolution in consequence of the steam trawlers.

"Yours faithfully,

"JOHN DOULL."

I consider that, where natural beds of Mussels have once existed, and the ground has not altered, there new Mussel beds may be established and cultivated; but the Government must grant provisional orders to persons desirous and willing to take in hand the cultivation of Mussels and Oysters, and not allow the officials at the Board of Trade to prevent the granting of such orders. The orders must enforce heavy penalties on persons illegally taking the molluscs, and provide for the imprisonment of those people who are unable to pay the fines and costs, as the greatest amount of poaching is done by the impecunious inhabitants of the villages adjacent to the shore, and whose forefathers a hundred years ago were the wreckers and smugglers of that age. Illegally taking Oysters and Mussels from such a fishery should be felony.

Mussels are largely cultivated on the continent. The exports from Antwerp for Paris alone, as recorded in the "Halles Centrales" Statistics for the season of 1873 amounted to seven million francs (£280,000). This represents the produce of natural beds and scalps unimproved by man's care.

In the town of St. Valery-sur-Somme, in France, artificial breeding, rearing, and fattening of Mussels, upon principles akin to those which obtain in ostreaculture, is carried on, and the success attained is such as to be worthy of a record in the history of attempts made to utilise the unbounded wealth of food lying ready to man's hand along the sea-shore. Lines of wattled stakes, averaging 530 yards in length, are driven in the sand close to the fair-way, just above low water-mark. These *bouchots de grand flot*, as they are called, extend over twenty-five acres. They serve for fixing the spat, which is floated up to them by the tidal currents, and constitute a collecting ground for brood, which are afterwards removed into shallow tanks of about fifty acres, dug out high on the strands between the tide marks. They are puddled with clay, and fitted with sluice-gates. The salt water in these tanks is slightly admixed with soft river water. They also serve as nurseries for the young Mussels, which hang in clusters and gather on wattles. When they attain proper size for transplanting, they are removed into the *parc*, where they will grow and develop into marketable Mussels. All this is being successfully carried out by M. Lemaire, who obtained from the French Government, in 1873, leave to appropriate a small strip of 40 acres of the foreshore fringing the low sandy estuary of the Somme. The success of this short experiment was so marked, that after an official visit paid by the Minister of Marine, and a number of *savants*, including M. Coste, who had predicted a failure, the original concession was extended to 620 acres.

There are numerous other places on the Continent of Europe where Oyster and Mussel culture is successfully carried on.

The secret of the whole matter is, where Mussel and

Oyster culture has proved successful, that the person undertaking the same has obtained a concession from the Government to work the beds exclusively himself, and has not been hampered by other persons claiming a right to fish on his grounds ; in other words, fishings are worked in precisely the same way as farms, where the farmer sows his seed, and at the proper season reaps his corn.

In England the laws allow the seed to be sown and protected to a certain extent, and when the molluscs are a certain size (*i.e.*, two and-a-half inches for Oysters, and two inches for Mussels), the whole world is free to come and fish on the beds by taking out a nominal licence, which is at the rate of 3*s.* 6*d.* per ton on the burden of the smack for one year, or 9*d.* per ton per month. This applies only to fisheries worked under the "Sea Fisheries Act, 1868."

To make the Oysters and Mussels the actual property of some private individual or body corporate appears at first sight to be rather hard on the so-called fishermen ; but it must be borne in mind that any person who undertakes to properly cultivate a portion of the foreshore for the increase of Oysters and Mussels must be in a position to expend a certain amount of capital, and therefore he would not very probably do much manual labour, but confine his energies to the employment of watchers or water bailiffs, to the making of "lays" or "parcs," by digging large reservoirs between tide marks, and the various other expenses contingent upon the enterprise ; so that the supply of molluscs would be greatly increased, and the fisherman or labourer employed would have more work than he has under the present exhausted state of things.

Under the "Orders" granted to the Corporations of Lynn and Boston for the cultivation of Oysters and Mussels, they have collectively jurisdiction over 229 square miles in the Wash; and I have no hesitation in saying that, if the Mussel beds in this area were properly worked, they are capable of supplying with bait the whole of the long-line fisheries of the country.

To catch the Mussel spat I have tried rows of wattled stakes placed in different positions on the beds as in France, but I found that they became covered with a green weed in a very short time, and were therefore unable to receive the spat.

I found that rows of stakes or blocks of cliff stone placed on the scalp remained free from weed and gathered the spat.

Mussels are used very largely for food in London, Manchester, Birmingham, Nottingham, Leicester, and other towns, the supplies coming from the Wash, Morecambe Bay, Devonshire, and large quantities from Bruinisse in Zeeland.

The Mussel is admitted on all hands to be the most deadly bait for salt-water fish, and from experiments I have made I believe the reason to be attributable to its tenacity to life. A Mussel taken from its shell and suspended on a hook in sea-water will be alive in two days. I am aware that fishermen are under the impression that they die shortly after being placed on the hook, but that such is not the case I am certain; the microscopic movement of the cilia on the four gills or branchiæ may be overlooked by a fisherman, but undoubtedly this lifelike movement is appreciated by the fish, and causes the Mussel to be the most deadly of baits.

The Mussel beds on the east coast of England are capable of supplying with bait the whole of the line fishing. The method of obtaining this bait up to the present has been for the Mussels to be sent from the Wash and other places by rail and by fishing smacks, in the winter time when they are wanted. The railway rates to the Northumberland and south Scotch ports vary from 20*s*. to 23*s*. 4*d*. a ton; in addition to this there is the cost of carting from the natural scalps, some distance to the nearest station.

I consider a great improvement might be made upon this by selecting suitable sites on the foreshores of the estuaries in the north of England and the firths of Scotland, and sending the Mussels to the north during the summer months, as small steamers, which will not run in the winter, will take them to the north for about 8*s*. to 10*s*. a ton during the summer months. This would decrease the cost of Mussels to the fishermen at least 20*s*. a ton.

DISCUSSION.

Mr. EARLL (of the United States Commission) said he had enjoyed the paper very thoroughly, and had gathered much valuable information from its details. He could see that it had required very careful research to collect the information which it contained. He was not specially familiar with the shell-fish fisheries of Great Britain, but, as he understood it, one of the principal objects of these Conferences was a presentation of facts which would be valuable to foreigners in regard to the fisheries of Great Britain, and, on the other hand, of facts in regard to other countries, which would be useful to the inhabitants of Great Britain. They had learned, during the morning discussion, of certain fishes that might be of importance to Great Britain, which had not yet been introduced, and of others which, though already introduced, were regarded as decidedly injurious, and it seemed to him that one of the principal objects to be attained was definite information on these points. He had recently learned from Captain Danewig, of Norway, that the soft clam (*Mya arenaria*) was very abundant on that coast, but that was not used either for bait or as food. He inferred that the same species was abundant on the British Coast—if he were mistaken on this point he should be glad to be corrected, but he thought the inference was that there were large quantities. In the United States they made very little use of mussels, although there were large quantities of them : the fishermen did not use them for bait, and the people, excepting a few in the vicinity of New York, knew nothing of their value as food. They substituted the soft clam, of which the people of Norway and Great Britain had not yet learned the value. Since coming into the room, he had hastily put together a few facts concerning the extent to which this species was used in the States. In the State of Maine 318,000 bushels, or 1,000,000 lbs. of this mollusk were used for bait and for food. In Massachusetts an equal quantity, if not more, and in the middle states 406,000 bushels, making in all over 1,000,000 bushels, having a value to the fishermen of $458,000. He had not the statistics for Connecticut, Rhode Island, and some of the other States where these shell-fish were also used in considerable quantities, but including them it might be said that over 1½ million bushels, valued at probably not less than $600,000, were used on the Atlantic sea-board. Some fishermen on the coast confined themselves to the quarrying, as it was called, of these shell-fish, for they had the habit of burying themselves two or three inches deep in the mud or sand of the shallow bays along the shore. This industry afforded employment to a large number of fishermen at a time when there was nothing else to be done. Some of the smaller vessels, not considered safe to encounter the winter gales, were taken into the shallow waters, where they served as hotels and work-houses for the men engaged in quarrying the clams. These men spent two or three months in gathering a vessel load, shelling and salting them, to be sold in the early spring to the vessels engaged in the great ocean cod fisheries ; whilst large numbers were also engaged, during the entire summer, gathering them to be sold in the larger markets for food, where they were prized very highly, not only by the labouring classes, but by the best people of the country. It appeared to him that the people of Europe had at their doors a large resource wholly undeveloped, and he should be very glad if, by calling attention to this question, he should in any way assist in adding to the stock of food, or to the readiness with which fishermen might procure bait.

Dr. DAY said he had made some inquiries with regard to the mussel fisheries last year when in H.M.S. *Crichton* on the east coast of Scotland. It had been suggested by Mr. Harding that the mussel beds should be granted to private individuals to work, because if they were left open to the fishermen they would work them out until nothing was left. But then a difficult question came forward. If these mussel beds were granted to private individuals, how were the fishermen to get their bait? They complained that when mussels were in the hands of private individuals, the charge was so great that they could not get bait for fishing. If any or all of these beds in one locality were given to a private individual under Government supervision, it ought to be on the distinct understanding that the mussels were forthcoming at a certain price, not a prohibitive one, and that the fishermen could have them at any time.

Mr. SAVILLE KENT had listened with great interest to this Paper, and thought the statistics would be of the utmost service; he also felt indebted to Mr. Earll for his notice of soft clam, which there was no doubt did exist abundantly on the coast of England, and might be utilised as it was on the coast of France. There were also half a dozen other species on the east coast, and which might be equally utilised as the food of man. They were mostly bivalve molluscs, and amongst them might be mentioned the bastard oyster, which was generally considered an enemy to the other oysters, because it filled up the places where they were cultivated. It was used, however, on the south coast of France, and might be equally used here. There was also the *Donax pentaculus* and *Venus mercenaria*, and the razor shell, which were all estimable food, and were appreciated on the coast of France and most parts of America.

Professor BROWN GOODE said the remarks of his colleague, Mr. Earll, about the distribution of the soft shell food clam, and the manner of its capture, reminded him of a subject which was frequently proposed for discussion at the debating societies and schools in America, viz., Is digging clams fishing or agriculture? It was the fact that along the entire coast of New England the agricultural population in many instances derived half their support in digging, with hoes and shovels, clams of various species. Mr. Earll had spoken of the *Mya arenaria*, but there was another species on the coast equal in abundance, the round clam, called also by the Indian name quahang, and sometimes called the wampum clam, because it was the shell from which the Indians made money; broken fragments of the shell were strung on bits of skin, and used as a medium of exchange. Then the *Venus mercenaria* also occurred everywhere from Cape Cod to Florida. Its production was almost equal in extent to most other species. Mr. Earll had estimated the value of the soft shell clam at about $700,000, and he thought the production of the round clam must be equal, or nearly so. When small it was considered a great delicacy on the dinner-table in the summer months when oysters were not in season. He was led to refer to this species from the fact that Mr. F. G. Moore, Curator of the Liverpool Museum, placed in his hands the other day a paper in which he described a successful experiment of the introduction of this round clam into the waters of the St. George's Channel, and he hoped it would take root here and become useful. There was another species closely resembling this, the sea clam, or hen clam (*Macter solidissima*). It was also abundant on the sandy shoals, and afforded bait to fishermen to something like $30,000 or $40,000 a year. This also might be introduced with advantage in the North Sea. Many species in America, as, for instance, the mussel, the whelk, the cockle, and the little *littarina* (the common name of which he did not know), were exceedingly abundant, but were not gathered by fishermen to any extent. He had great pleasure in moving the vote of thanks to Mr. Harding for his Paper.

Alderman SMETHURST (Grimsby) had great pleasure in seconding the motion. He said he was aware of the difficulty of blending instruction and entertainment together to the satisfaction of an audience, and this seemed to be more a question to be reasoned out amongst a number of gentlemen practically acquainted with it in Conference, than to be talked about in a General Assembly. Speaking of bait, they all knew what was most suitable for their own localities in fishing, and the bait used differed considerably in different localities. In some parts they used mussels for fishing along shore within sixty or seventy miles of land, but when they got beyond that they used different kinds of fish for different seasons. When they got on to what was called the "shawl" of the Dogger Bank, in the spring of the year, when the fish began to accumulate in the warm weather, they used whelks, when they went down at the fall of the year to the north end of the Dogger deeper water, they began to use lamprey eels along with whelks, to assist in catching two or three kinds of fish which harboured there; as they extended further across the sea the bait was changed again, according to the season of the year, and the depth, and the clearness or thickness of the water. In some parts they used lamprey eels for clear water, but when they got to about two hundred miles away, they then took what they considered a different class of bait to fish in deeper water. There they caught cod, ling, halibut, skate, and haddock. The bait used was lampreys, as a rule, and later on herrings. In clear water the herring was the most suitable fish; in thick water they used whelk bait, on account of the smell, which attracted the fish when they could not see it. In the summer time, when on what they call the Little Fisher Bank, they used herring principally for taking large halibut and ling. At this particular time of year they were fishing close to the coast of Norway on the stony ground, a place which he and his two sons opened out four years ago. They were now on the ground using mackerel for taking halibut weighing from 7 lbs. up to 16, 18, and 20 stone. They used vessels carrying 6 and 7 tons of ice each, and they were employed for seven or eight months in the year. Grimsby might be considered the largest fishing port in England. It received upwards of 100,000 tons of fish in a year. The whole of this was not sent into the country for food, but part of it was used for bait, whilst a great part came to London, Manchester, Liverpool, Birmingham, and the large manufacturing towns. It was very right that this shell-fish should have every care and culture, and should not be allowed to be wantonly destroyed, because fishermen must have bait before the fish could be caught, and if the brood of the mussel were destroyed, and the whelks, the amount of fish caught would be greatly affected, and if it even became scarce and dear, people would have to pay a greater price for the fish they eat. The great cry everywhere now was how to get cheap fish into London, and that was a question to which he had devoted all his energy for the last thirty years, and had given his opinion when on the Commission which sat in London some three years ago.

The motion having been put and carried,

Mr. HARDING in reply, having thanked the Congress for the manner in which the Paper had been received, said there were few clams in England. On the coast which he hired, of about five miles, the men did not get a dozen in a day. With regard to the restrictions of price, he could only say that he had several thousand tons of mussels suitable for bait, and could not dispose of them at any price.

Mr. BIRKBECK, M.P., then moved a vote of thanks to Mr. Tyssen-Amherst for presiding. He felt specially indebted to him, being the representative of one division of his own county, where this question was one of great importance.

Mr. TOLLEMACHE, M.P., in seconding the vote of thanks, said, although there had not been so large a meeting as he had hoped, there had been a most interesting discussion.

The vote of thanks having been carried unanimously,

The CHAIRMAN said it was a great pleasure to him to associate himself with the subject of this Paper, in which so many fishermen on the coast took an interest. The mussel did not make a great stir in the world, like many of the fishes, but it was not to be despised on that account. He asked Mr. Harding just now whether any pearls were found in the mussels on our coast, but he informed him there were not, but there were some in many of the fresh-water mussels. If he mistook not, when he was at Conway, where there are thousands of mussels, he was informed that pearls were rather numerous. The discussion had been of great interest, showing the different kinds of molluscs that inhabited various parts of the coast, and also that many which were not appreciated here were set great store by in foreign countries. In human affairs it often happened that small things were overlooked, and, like the mussels which were trampled upon on our shores, had to go to the wall; but Providence ordained that they performed in a humble way a very important function, and, with the great monsters of the deep, contributed to what was so well represented in the Exhibition, the harvest of the sea.

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CRUSTACEANS

BY

THOMAS CORNISH

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1883

CONFERENCE ON MONDAY, JULY 23, 1883.

MR. JOHN TREMAYNE in the Chair.

CRUSTACEANS.

I HAVE been requested to read to you a short Paper on "Crustaceans."

The Crustaceans are a large class of articulated animals whose distinguishing feature to the mere outside observer is that they are covered over the whole of their bodies and legs by a shell of more or less hardness, and it is this total covering in a coat of mail which mainly sets them apart from other classes of animals.

They are found on the land, in the fresh water, and in the salt water : and, amongst themselves, are divided into two distinct varieties, ie., the "Sessile-eyed"crustacean, in which the eye lies flat in its socket, with just the amount of mobility and scope of vision which the eyes of most animals have ; and the "stalk-eyed" crustaceans, in which the animal has a certain limited power of projecting its eye, at its own will, beyond its socket or immediate surroundings, and so obtaining a considerably enlarged sphere of vision.

With the single exception of the common river crayfish I shall confine myself to-day to the crustaceans whose home is in the sea.

Among these I shall very curtly dismiss the "Sessile-eyed" class, with the remark that no one of them has any interest for us except from a scientific point of view. Practically, so far as they affect us at all, they are objectionable. To them belong the "Hoppers" which make our beaches, and especially those on which sea-weed is apt to accumulate, unbearable on a hot summer's day, and as well that curse of the fisherman who uses trammel nets, one of the gammaridæ which, in countless numbers, will clean to the bone, within eight hours, a fish caught in the net, and send it up as white and neat as ever the Royal College of Surgeons set up a skeleton.

I think I may say that so far as the word "crustacean" conveys any definite idea to the minds of the majority of those here it carries the meaning of "crabs and lobsters;" and I take these animals, which are not unimportant as sources of food supply, with the addition of prawns and shrimps, and their congeners, as the subject of my present paper.

If you will look at the next lobster, or crab, or shrimp, which you may see, you will, with the delicate use of a fork in the case of a boiled specimen, find that it has, or had, an eye placed at the top of a stalk, or pedestal, based within the socket of the eye on a moveable mechanical joint, and there receiving the usual information from the brain of the creature through the nerves. You will find that the socket of this eye is invariably protected by spines of a strength proportionate to the size of the creature, and that this eye can be projected or retracted at the will of the shell fish. It resembles in some respects the telescopic eye of the snail, but it is not capable of anything like the same protrusion nor is it so mobile. In the "shrimps" the eye at its full protusion and elevation rises above the level back of the animal to an extent which enables it to see all round it.

Any one who has watched a shrimp in a small pool of salt water will acknowledge this. Most shrimps are so semi-transparent in water that it requires a practised eye to observe them, but, once see a shrimp leisurely making its way across a pool, thinking of nothing at all, and alarm that shrimp by putting your walking stick in front of it, and you will at once (but to see this you must have learned to watch nature closely) see it raise its little black eyes, take a rapid view of the ground in its rear, and with one flip of its tail disappear stern foremost into the hole it has selected for its place of refuge.

The arched back of the crabs and lobsters prevent the same thing occurring in their cases, but they yet derive a very greatly increased scope of vision from their power of thus protruding their eyes. Quite recently a specimen of a little lobster-like creature, *Scyllarus arctus* (it is so rare in English waters, except in Mount's Bay, that it has no English name) has come into my possession which I have preserved and have with me. It is worthy of notice, not only because its eye is an exceedingly good example of the "stalk-eye," but because I believe only three specimens (two off Plymouth and one from the stomach of a cod taken off Polperro) have been seen in England out of Mount's Bay. In that bay I have secured some twenty specimens, many alive and full of spawn ready to be shed, as was the case with the specimen I have with me. There is reason to believe that it was observed in Mount's Bay so long ago as the middle of the last century; but it is distinctly a crustacean of the Mediterranean Sea.

Confining myself now to these stalk-eyed crustaceans of the sea, I may say that something over one-hundred species have been recorded as having been observed in British waters. A large proportion of these, perhaps one half, are of the small shrimp and prawn order, which are not carefully looked after, except by naturalists making the study of them their speciality. Of the others (to which I have given much practical attention) I have captured in Mount's Bay with my own hands certainly four fifths of the species known to exist, including many of the rarest specimens occurring in our seas.

I may explain that the reason why I have seen so many species of crustaceans more than my neighbours is that I have fished for them myself. Most of the sea crustaceans are small and considered valueless. This is a misapprehension, nearly all of them yielding dainty food; but the fisherman is intensely conservative in his instincts, and it is a very difficult thing to get him to preserve a crab or a lobster or any of the class which has not already established itself as an edible and saleable commodity. To begin with, they are all his natural enemies. Unless they are caught in the legitimate crab-pot, from which all small specimens can escape, they are taken in his nets. They come into the net in pursuit of the best fish caught in it, and they get entangled. So long as they have life they are using their claws to cut the cords of the net, and so it happens that every crustacean does damage to the net which captures it. The fisherman, intent on his better fish, never waits to disentangle a crab of any sort unless it is a valuable one. He simply wrenches off its legs or lays it, in the net, on the gunwale of the boat and smashes it with his hand to deprive it of the power of doing further mischief, and goes on with the hauling of his net. Thus, rare crustaceans are rarely recognised. I have had in the last thirty years constant opportunities of reversing this process, and of carefully picking out of my nets thousands of little crabs which would have been passed without notice by the ordinary fisherman: and consequently, partly on that account, and partly on account of the situation of Mount's Bay, I have seen more species of marine stalk-eyed crustaceans than most people.

As the typical "stalk-eyed" crustaceans of our British waters you may take the common lobster, the common crab, and the cray-fish (either salt water or fresh water—it does not matter which). You know about the size of these. The largest crab on record weighed something over 13 lbs., and its preserved shell is now in Mr. Laughrim's collection in the Natural History Department of this Exhibition. The largest lobster (the specimen is in the same place) weighed something short of 12 lbs.* The sea cray-fish is, to look at, a larger animal than either the crab or the lobster, but, having no large claws, always turns out of lesser weight size for size.

But what are these puny creatures to the stalk-eyed crustaceans of other days! I do not now refer to the sprawling spider crab exhibited in the Japanese Department of this building, and which measures I believe, ten feet from finger tip to finger tip; but to that huge, solid lobster-like crustacean disclosed to us by geological research, and which must have been some eight feet long in the body, and have contained meat enough to make a salad for a regiment of soldiers!

Still, as we only have these little specimens left, we must do the best we can with them; and the first thing to which I will call your attention is a matter which strikes the observer last of all. You probably know that crustaceans are propagated from eggs which, whilst in the body of the lobster, or cray fish, are found in the form of "coral," but which when further developed appear outside in the form of "berry." In this latter form you also find them in the crab. From these eggs are hatched some wonderful little creatures of intense activity, resembling nothing so much as the animalculæ shown by the microscope in a drop of ditch water. They are as unlike the shellfish they are to become in mature life as a grub is unlike a butterfly, and, curiously enough, they are sessile-eyed.

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* There is a specimen of a Lobster in the Fishmarket, I.F.E. which weighed over 20 lbs., but it is from America.

I will now go on to the lives of the crustaceans after they have assumed their final shape. They all are much of the same size when extruded from the egg; but at maturity they vary from the "common Pea-crab" or from "Andrews's Galathea," either of which at its full maturity can be placed on a threepenny bit and leave an ample margin, up to the largest of our lobsters, crabs, and crayfish. When I was learning these matters the late Professor Bell used very kindly to allow me to send to him for identification any specimens about which I had any doubt, and in 1864 I procured from the submerged part of a deep sea buoy specimens of two very tiny crabs, neither of which was more than $\frac{1}{4}$ inch across the back. One, I thought, I identified as *Eurynome aspera* a crab so rare that I dared not mention it on merely my own authority. The other I could not make out at all, so I sent both to Professor Bell. To my extreme delight he told me I had *E. aspera* in its young, but final, form, but he took all the pride out of me by pronouncing the second specimen to be a young common crab. I mention this to show how tremendously this latter crab increases in size and bulk.

And as to this question of bulk. The stalk-eyed crustaceans are, as we have considered, enveloped in a hard and non-elastic coat of mail. We have seen that they increase enormously in size. How then do they grow? They grow in this way : Once in every year, and, of the same species, at the same time in every year, the crab or lobster, or cray-fish or shrimp, instinctively retires to some lonely hole in the rocks, and mopes until a crack in the shell occurs across it, precisely where the carapace or back ends, and the tail begins. So soon as this happens the animal begins to drag its whole self out of the shell. In from half an hour to an hour it has drawn the flesh of its great claws out of their shells through the little wrists, and has even drawn its eyes out of their protecting cases or pedestals, and has cleared itself of its old shell altogether, and it lies beside it a perfect crab, or whatever else may be its shape, but quite soft and shell-less, and apparently exhausted. The empty shell also retains its perfect shape ; but a comparison of the two shows you at once how the growth takes place. The real crab is sizes larger than its late shell, and in about a week a new shell has hardened over it, and this process is repeated yearly, as I have said, until a period of age comes at which it apparently ceases, and the creature grows no more. We judge this because we find that our very largest specimens are always covered with corallines of very slow growth.

Probably most of you consider of a crab or lobster as you see it on a fishmonger's stall, a squat thing with its legs sprawled out. But they are very different when alive and in the sea. Then those long legs are in their proper position, and the shell-fish walks on them daintily, with its long antennæ or feelers out in constant motion searching for its food. The lobster is a foul feeder, and prefers its food in a state of putridity, or at all events, not fresh ; but the crab will touch nothing that is not fresh. Any of you acquainted with the working of aquariums may be able to correct me in this statement ; but I make it from my practical knowledge of the baits we use in fishing for crabs and lobsters. In each case we use fish bait. I once discovered a benighted little fishing cove where the fishermen actually commonly used large turbot and red mullet —a pound and a half and over in weight—for bait for crab. They had no market for turbot and red mullet, whilst they had for their crabs and lobsters. Having, of course, much finer gear with me than they used, I very soon harried the inshore sands, and established a barter market in which one turbot of good size was exchanged for one ray of any size, and a small ray equalled a good red mullet. When ray were scarce with me, the market price of a turbot was 1*s.*, and that of a red mullet 6*d.*

To this question of the bait offered to—which means, of course, the favourite food of—some crabs, I can offer another illustration. The red mullet which we catch are taken in fixed-bottom fishing nets called trammels, and the fish caught in these nets frequently remain for many hours before they are taken out, and we find that crabs, and especially the spider crab—our English representative of the gigantic crab in the Japanese Court, of which I have made mention—always attack the liver, the dainty part of a red mullet, first. Sometimes they eat more of the fish; but the liver invariably suffers first. We know this because from the peculiar formation of the net the attacking crab is almost invariably captured with its prey.

But this fact of the preference of crabs and lobsters for soft bait suggests another question. If the food which they preferentially seek is of this soft nature why should they be furnished with claws of such tremendous cutting and crushing power? Every crab and every lobster is furnished with a claw (the smaller one) adapted for cutting as scissors do, and another, the larger one, adapted for crushing; and between these two claws they can tear every bit of food they capture into little fragments and feed themselves with it, literally "from hand to mouth." It is a very pretty sight indeed to see the tiny *Galathea Andrewsii*, of which I spoke just now, kept in the holes of a clinker, in a soup plate filled with salt water, come out of their holes when the water is stirred, and feed themselves with particles of food utterly invisible to the unassisted eye, by capturing some passing bit of food in their elegant little claws and conveying it to their mouths, precisely as we should do with a cherry or bit of biscuit. Crustaceans are slow of movement, and may have to feed on things of a much harder nature than the bait with which we fish for them. This may explain the necessity for their having such powerful hands, for their claws are but hands. But then, as they are an exceedingly pugnacious class of beings, it may be that the extraordinary power given to their hands is needed for belligerent purposes. A crab will fight anything. I have seen a captured crab seize a captured picked dog-fish by the tail, and the dog-fish, striking backwards, as is its wont, make its spines "click" (ineffectually of course) on the back of the crab repeatedly; until the crab got a grip with its other claw on the dog-fish's throat, and then the battle was over. Of course a crab, size for size, is much harder and more powerful than a lobster. I have seen a crab, in conflict with a lobster, catch the latter over the forepart of the head, where its shell is hardest, and crush it in by one effort. No lobster could do this to a crab fairly its equal in size. And it rather bears out my idea that the claws of these creatures are weapons of war rather than means of providing themselves with food, that the moment any one of them receives severe injury in a claw it "shoots" it, that is, it deliberately severs the connection of the claw with the body at the shoulder—the joint next the body—by an act of its own will, and that Nature regularly and repeatedly (but on each occasion with less effect) reproduces the claw on a smaller scale than the one shot off. It seems probable that if the large claw was necessary to the feeding of the animal Nature would rather seek to cure an injury to it than let the animal discard it altogether; but the crab makes no two ways about it. Within a second of the injury received the whole limb is discarded; and lobsters are much more apt to do this than crabs. This known difference in the temper of the two came out once very funnily whilst I was fishing. We value lobster much more than we do crab. A crab, when it catches you, holds on with a crush much harder than does the lobster. An old boatman of mine once, whilst landing a lobster, got caught by it over the thumb. Any violent act of resentment would have made the lobster shoot its claw; and I looked round just in time to see the boatman balancing the lobster up and down from the gunwale of the boat, bearing the pain of the pinch, and apostrophising it with "Ef thee'd a-ben a crab I'd ha' smashed thee agen the gunnel."

But, having dealt with the food of crustaceans, we will deal with the crustaceans as food. Many of the smaller species—all, in fact—are utilised as food by fish of several species (families, I may say). Thus the family of the cod (*Gadidæ*), and of the flat-fish (*Pleuronectidæ*), feed largely on stalk-eyed crustaceans, and so, indirectly, make them available to us as food. So well is this fact known amongst those interested in the subject that no one of them would permit the stomach of a cod or a dorse, and some other allied species, to be thrown away without a careful overhauling first. The first recorded specimen of the rare crustacean, *Scyllarus arctus*, to which I have alluded was found by my friend the late Mr. Jonathan Couch in the stomach of a cod. The only specimen I ever saw of a crab called the long-legged portunus (*P. longipes*) I obtained from the stomach of a dorse. But specimens thus obtained are of course not available to us as food. We have recognised the value of the larger species, and passed no end of laws to protect them in their earlier stages. For about three families we have made close times and size-rules, and all the rest of it. I do not know but that in some districts these things may be beneficial, but I do know that the Commissioners who inquired into the matter found that there existed off the Land's End one solid bed of crab and lobster deep-sea fishing ground of at least 200 square miles in extent; and they thought, and I think with them, that it will take a good many centuries to exhaust that field by any method of fishing. The crustaceans of that district and the coal of England will be exhausted much about the same time. I am not aware that any fishing ground approaching this in extent exists elsewhere in Great Britain, and I approve of the legislation which has taken place. Where the area of production, and therefore the area of fishing, is limited, protection is absolutely necessary if the efficiency of that particular fishery is to be maintained. By actual experiment I have ascertained that a common edible crab (*Cancer pagurus*) measuring three inches across the carapace, or back, turns out one ounce and a half of meat available for food, whilst a crab of four inches across the carapace (a size which a three-inch crab would probably attain in its next year of growth) turns out four and a half ounces of meat available for food. Clearly therefore the young crab should be protected, but the enforcement of protection by law is very difficult. It might be otherwise if the men who fish limited areas could be made to understand that in the long run close protection will prove their best friend.

We are eating these large crustaceans as luxuries, and we are eating shrimps and prawns as dainties; but between these two there exist several species of crustaceans which attain maturity at a size of from three to five inches across the back which we never think of eating, but which yet are full of excellent meat. We make a delicacy of the river crayfish, but we despise, or rather utterly ignore, the spider crab, the shore crab, the two larger *Xanthos*, the velvet swimming crab, the *Galatheas* (squat lobsters) and many others—including the one, *Scyllarus arctus*, which I have mentioned, but which must, in the present state of our knowledge about it, be treated as of very local permanent occurrence in our seas; other observers than myself, placed by my experience on the scent, may establish it as a common inhabitant of our waters. Of all of those, untold stores might be captured along all our rocky sea-shores, and all of them yield good food in larger quantities, and with not much more trouble, than would an average prawn. We do not trouble about them, and their capture is, as I have shown, a chance affair; but go to the Japanese Department, or the Chinese, or even to our own Department of Speculative Ideas in this building, and see what endless pots and models of pots and traps there are exhibited there, designed on purpose to catch prawns and shrimps, but which would also catch these wasted treasures of the sea, if they were looked after.

This waste of food supply is due to two causes—one is that the "men that know" (the scientific naturalists) take no measures to reduce their knowledge into practice. And the other is that the "men that work" (the fishermen) are naturally, as I have said, unwilling to save sea produce which is worse than useless to them without a market. This remark applies equally to enormous quantities of fish which are captured constantly in ordinary trawling, and, because they are strangers to the fishermen and will not find a market, are thrown overboard as useless. It is not quite germane to my subject, but if it were I could dilate on scores of species of fish constantly taken in our seas, excellent as food, and thrown overboard simply because, being unknown, they would find no sale. If this Exhibition can, as one only result, break down the arrangements which keep good and cheap, but comparatively rare, fish out of the public markets, and so cause the demand which can and will create a supply, it will have conferred a very great boon on the English public; and I do not see why it should not do it. I have never yet seen a fish that is unfit for food, if in good condition at the time of its capture; and in saying this, I am saying much, for I have made it a rule to have cooked the second specimen of any rare fish which I get. The first is of course set up for some museum.

There is another thing about our smaller crustaceans which is worthy of notice. Some of our little crabs—and I dare say more in other species than I have noticed—give us notice in spring of the fish which we may expect in autumn. For instance the occurrence in free numbers in April of a small crab known as the "masked" or "old man" crab (*Corystes cassivelaunus*) in particular localities always assures us that about August we shall in the same locality get an abundance of plaice, and soon after that large red mullet. When I say large red mullet I speak of fish weighing from 42 oz. (the heaviest ever recorded in British seas, and taken in Mounts Bay) to 25 oz., and thence to 16 oz. At this time these facts are to us coincidences, and nothing more; but if they were closely followed up by many observers, they would produce for us more good fish than we get on our present haphazard principles.

I spoke just now of the very combative nature of some of the stalk-eyed crustaceans. The species that most excel in this quality are the soldier or hermit crabs. Their first idea of independent life is to eat some friendly whelk, and occupy its shell. Their next is to give battle to every crab of the same persuasion as themselves that they come across; and altogether they form, as you can see in any aquarium, the most quarrelsome and most amusing set of crustaceans in existence.

It may seem utterly absurd to speak of these hard-shelled crustaceans as capable of suffering from skin-disease, but it is nevertheless the fact that they are so. Under certain circumstances, of which we know nothing, a peculiar cancerous eating out of the outer part of the back and claws takes place, spreading irregularly like a map over the crustacean, and showing a black colour. Shell-fish thus attacked are known as "pocked" crabs or lobsters, and are unfit for food; but I need not labour this point further, because I know of no fisherman who would send a crab of this sort into the market.

One more statement of a fact (some people might call it an anecdote) and I have done. Most of you probably know that on a dark summer's night the water of the sea, to the depth of as much as twenty fathoms, is from some cause or another luminous when disturbed. When this phenomenon occurs, a fishing line can be traced down its whole length, and a fish caught at the bottom of the sea comes struggling and sprawling up in a blaze of phosphorescent light. I was once fishing in about fourteen fathoms of water, when I hooked a fish. I hauled it up, making as it came a most prodigious luminosity. When it came alongside, my boatman struck at it with the gaff, and off from amidst the mass of phosphorescent light the iron gaff came with a click. He struck again with the same result. And he said, "This thing is not right, master; let it go." I did not. I gave a dead haul, and got aboard a very large sprawling cray-fish. It was not, as my boatman had supposed, a direct emanation from the regions below.

DISCUSSION.*

Mr. Kenneth Cornish, after some remarks on the value of fish as food, having particular reference to a paper read by Sir Henry Thompson at a previous Conference, was going on to describe an improved method which he had adopted for cooking food, when he was reminded by the Chairman that the special subject of the Conference that day was crustaceans. He said he would not detain the meeting, but had also devised a method for preserving fish in the form of powder, by which the whole of the nutritive constituents were preserved, including the albumen.

Mr. Birkbeck, M.P., then moved a vote of thanks to Mr. Cornish and to Mr. Saville Kent for their interesting Papers, which had contained a deal of information which was probably new to many persons present. Mr. Cornish had told them of a remarkable fishing ground on the coast of Cornwall, which might be safely fished without any restrictions, whilst on the other hand Mr. Saville Kent had given statistics proving that the supply of lobsters was apparently decreasing rapidly. He might say that on the coast of Norfolk there was a small lobster and crab fishery on a ground of about fourteen miles in length by three to four miles in breadth, which many years ago was a very productive fishery, but unfortunately the practice of breaking up small crabs for bait, and also the practice of sending to market berried hen lobsters, was carried on to such an extent that the fishery was reduced really to nothing. He was asked to institute a Board of Trade inquiry, and the late Mr. Buckland and Mr. Spencer Walpole came down and held it ; the result being that an order was passing putting a stop to the capture of berried hen lobsters and also the soft crabs, and the fishermen were strongly advised to stop the breaking up of small crabs for bait. That order was in force for three years, and when it expired, which was on the 1st of February this year, another inquiry was held by the Board of Trade, under the supervision of Professor Huxley. The evidence which was given, not only from the fishermen, but the salesmen, was so convincing as to the effect of the order being to increase the supply to four or five times what it was previous to the order being passed, that the Board of Trade had now passed an order putting a stop to the practices which were in vogue for ten years, and the fishermen had made up their minds that they would endeavour to get a local Act passed to put a stop entirely to the breaking up of small crabs. That showed what could be done in a small district, and he hoped it would be carried out throughout the country.

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* The following discussion and motions carried, refer in part to a Paper that was read the same afternoon by Mr. W. Saville Kent, on the subject of "Artificial Culture of Lobsters."

Mr. BRADY had much pleasure in seconding the resolution. He did not know that there was any question more interesting than that of crab and lobster fisheries, unless it was the artificial cultivation and production of salmon and trout. He quite agreed with Mr. Saville Kent on the great importance which would be derived from the artificial cultivation of these fish in the same way as salmon and trout, but he did not follow him so far as to think that the same instruments or conveniences could be used for one as were used for the other, inasmuch as one must be carried on near the sea, and the other far inland. With regard to the cray fish, he agreed with him it could be done, but that was only a matter of detail. He feared, however, it would be like other matters which were for the public good, that it would be hopeless to expect private individuals to undertake it. This subject, along with the artificial propagation of the better species of fish, and probably, eventually they might come to that, was a matter which concerned the State more than private individuals, and he thought it would be found very difficult to find private gentlemen so scientific as to go to the very large expense which would be required, without any certainty of recouping themselves or obtaining interest on the money.

The resolution was carried unanimously.

Mr. CORNISH, in reply, having thanked the meeting, said he would make one remark on Mr. Saville Kent's paper, that was with regard to the use of the berry of the lobster. If they could only bring it home to the minds of cooks that the berry of the lobster was absolutely tasteless, or if it had any taste at all it was a slightly unpleasant taste of iodine, and that, therefore, it was only valuable as a colouring matter, there might be some hope of putting a stop to the present practice of using it for sauce. He then proposed a vote of thanks to the Chairman for his kindness in taking the chair. He had known him for some years as a practical fisherman, and he was sure a better chairman could not have been selected.

Mr. SAVILLE KENT seconded the motion, which was carried unanimously.

The CHAIRMAN said he could assure the Conference it had given him great pleasure to be present that day, because this question of crustaceans was one which must interest every one. The lobster and crab fisheries had always had a peculiar interest to him, because it was essentially a fishery for poor men. The crabbers generally worked with their own hands almost, and in their own little boats, and were exposed to almost as hard work as any toiler of the sea, so that anything which could be done to protect their interests, or increase the supply of this fish, would be most valuable to the fishing community. With regard to what had been said about legal interference, he might say that in 1877 an Act of Parliament was passed to a certain extent protecting crabs and lobsters, by prohibiting the sale of undersized fish. The question of berried hens, as they were called, was very much discussed when that Act was passed, and he took a great deal of trouble to get information and evidence with regard to them. It was not the cooks alone who were to blame in causing berried hens to be sent so largely into the market, the fishermen themselves doing it, because the lobsters having berries on them were in as good condition for eating as at any time in the year, and if the sale of berried hens were to be prohibited, as Mr. Kent remarked, and as he had heard from the fishermen themselves, they would simply evade the law by brushing off the berries. The size of crabs was another question which was very largely discussed, and, as Mr. Birkbeck could bear him out, the people in Norfolk, where crabs were not as large as on the south and west coasts, were in favour of a larger size being named than that which was placed in the Act, viz., 4¼ in. across the crab's back. That was such a tiny thing, and contained so little meat, that a very small extension in the size would produce much more valuable food for the table, and the fish would increase its species in an enormously large proportion. With regard to the district which Mr. Cornish had spoken of, where fishing could be carried on for over 200 square miles without doing any harm, he would point out that there was a great natural protection existing there, for that fishing ground was exposed to all the tremendous rollers of the Atlantic Ocean, so that it could not be fished so constantly and incessantly as inshore crab fisheries, and those places around the shore where it was acknowledged on all hands that crab and lobster fisheries required protection.

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International Fisheries Exhibition
LONDON, 1883

ON THE

ARTIFICIAL CULTURE

OF

LOBSTERS

BY

W. SAVILLE KENT, F.L.S., F.Z.S.
Late Assistant in the Natural History Departments of the British Museum
AUTHOR OF 'A MANUAL OF THE INFUSORIA,' AND OF OFFICIAL GUIDE-BOOKS
TO THE BRIGHTON, MANCHESTER, AND WESTMINSTER AQUARIA

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1883

International Fisheries Exhibition,
LONDON, 1883.

CONFERENCE ON MONDAY JULY 23, 1883.

JOHN TREMAYNE, Esq., in the Chair.

ON THE ARTIFICIAL CULTURE OF LOBSTERS.

ONE of the most important objects of the Conference held in connection with the International Fisheries Exhibition is, I anticipate, to elicit data that may be utilised for the improvement or resuscitation of our many fishing industries already established, and for the opening up of new fields that may give employment to the fishing community, and increase the supply of wholesome food for the use of the masses.

Taking this for granted, I here propose to submit to you the results of some practical experiments made on my part some few years since, in connection with the artificial cultivation of lobsters, trusting that the deductions I have arrived at with relation to the same may contain, at least, some crude ideas that may be hereafter fashioned into shape and prove of utility to the public.

The lobster, I need scarcely remark, occupies a front position in the ranks of our food fishes. Its intrinsic value, weight for weight, is little inferior to that of salmon, while its nutritive and restorative properties as an article of diet, are, in accordance with the latest dictum of the medical faculty, vastly superior. An idea of the inadequacy of the supply of this crustacean, obtained in British waters, to meet the public demand, may be gained from the statistics contained in the Government Report upon the Crab and Lobster Fisheries, published in the year 1877. Herein it is shown that, upon an average, no less a number than one million of lobsters are imported annually into the United Kingdom, in the living state, from Norway alone, which is the chief source of our supply, this million, at the date quoted, representing a money value of about £22,500.

Statistics are likewise here given of the numbers of lobsters annually derived from different portions of the British coast line, the keynote and burden of the whole report being, however, the unwelcome, but only too familiar intelligence, that lobsters are continually becoming scarcer and dearer, and that the fishermen have, year by year, to go further afield, dividing the large profits, once accruing to the few, among the many, to meet the requirements of the market. The lobster, not many years since within easy reach of all members of the community, is in fact rapidly following the lead of the native oyster, and threatens soon to be a luxury at the disposal only of the wealthy. A quotation from the report already referred to will suffice to establish this assertion. Here is the testimony we find on many a page. England and Wales : "Crabs and lobsters are decreasing ; they are overfished." "The grounds in-shore have been fished out, and the men have to go to deeper water." Scotland : "A very large majority of the witnesses, with special means of arriving at a just conclusion on the subject, are satisfied that the crab and lobster fisheries of Scotland are in a state of gradual decay." Of Norway, our richest source of supply, a Mr. Fisher, one of the Billingsgate salesmen most extensively engaged in the Norwegian lobster trade, gives evidence thus :—"The supply has fallen off during the last seven years. Ten or twelve years ago he used to import 600,000 lobsters a year from Norway, from three districts only. He is now working six districts, double the amount of coast, and the six districts only produced last year from 400,000 to 500,000 lobsters." Other evidence elicited by the Commissioners resulted in their verdict that "there is little room left for doubting that there has been a very serious falling off in lobsters in Norway."

The causes that have contributed towards the decadence of the lobster fisheries generally are relegated in the report to three distinct categories. 1. The overfishing of the inshore districts. 2. The destruction of undersized fish. 3. The consumption of the eggs or spawn for culinary purposes. For the second only of the evils thus summarised—that of the destruction of undersized fish—has a remedy been actually applied, and beyond doubt with highly beneficial effects, through the appointment for lobsters of the eight-inch gauge, fish within which length, by the Act 40 and 41 Vict. c. 42, 1877, are now of illegal size. The suggestion of a close time for lobsters during their spawning season, to prevent overfishing and to protect their eggs, has not been found practicable, since it would, in the first place, interfere unjustly with the inherited rights of the fishermen, while, in the second instance, it would interrupt the supply at the period when lobsters are, as an article of food, in their very best condition.

Assuming for the time that both the protection of the undersized young and that of the adults, during the spawning season, had become binding by law, I feel justified in asserting that we should have, even then, only arrived half way towards the root of the evil, and that the prime factor in the decadence of our lobster fisheries is to be found in the permitted wholesale destruction of the lobster's spawn. Comparing matters with the law as it now exists, with relation to the trout and salmon fisheries, the foregoing regulations, if enforced, would, in fact, leave us in precisely the same position as obtained with these important industries prior to the introduction of the artificial system of cultivating and protecting the eggs and fry of the Salmonidæ. To all who have given attention to this subject it is a well-known circumstance that, but for the introduction of the artificial system of culture on the part of patriotic pisciculturists, our lakes and rivers would never have recovered from the exhausted condition to which they had been reduced by overfishing. Now, what has been achieved in connection with the Salmonidæ I am prepared to maintain is capable of realization with the lobster tribe. That lobsters may be artificially cultivated from the egg I have already proved by practical experiment on a small scale, and to demonstrate that the same principles applied upon a wholesale one might be utilized for re-stocking our exhausted inshore fisheries is the chief object of this communication.

In order to place you fully in possession of the circumstances and capabilities of the subject introduced, it is desirable that I should give you a brief sketch of the early life-history of the lobster. As is familiar to all present, the eggs of the lobster, upon extrusion, are attached in masses to the filamentous appendages, or "swimmarets" of the abdomen, or so-called "tail" of the lobster, and constitute what is popularly named the "Berry." The amount of eggs extruded by the female fish, it is singular to observe, coincides remarkably with those of the salmon, numbering from 20,000 to 30,000. Attached beneath the parent's abdomen, in the form of "berry," the eggs remain for a period of three or four months, and then the young are hatched. No nutritive or other than a purely mechanical relationship subsists all this time between the parent and its egg-clusters, the passing of its small brush-like claws among them to rid them of any extraneously derived substances, and the occasional fanning motion of its swimmarets to increase the stream of oxygenated water through and among the eggs, representing the sum-total of attention they receive.

The young animals that issue from the eggs of the lobster are distinct in every way, including shape, habits, and mode of locomotion, from the adult. If, on the contrary, they were born like their parent, they would at once sink to the bottom of the water in the immediate neighbourhood of their birthplace; the area of their distribution under such conditions would be extremely limited, and through close interbreeding, it may be anticipated that the stock would become materially deteriorated. Nature, here, however, as in the case of the great majority of marine invertebrate animals, has provided her offspring with special facilities for becoming distributed to long distances, their bodies being so lightly constructed that their specific gravity scarcely exceeds that of the fluid medium they inhabit, while they are additionally provided with long feather-like locomotive organs, with which they swim at or near the surface of the water. As such essentially free-swimming, pelagic animals, they now spend the entire first month or six weeks of their existence, in which time, it is scarcely necessary to state, they may be carried by the tides and currents many miles away from their place of birth. During this interval, however, the little lobsters by no means retain their primitive shape; their delicate chitinous skins, the rudiment of the future shell, is constantly getting too tight for them, and is thrown off to give place to a larger and looser one, that differs each time in many structural points from its predecessor. As determined by my own experiences, such a changing of the skin, or "ecdysis," as it is technically termed, is effected no less than half a dozen times before the little animal arrives at the ambulatory condition, and takes upon it the form and features of the parent. This chapter in the life-history of the young lobster is of the most interest, perhaps, when studied by aid of the recently kindled, but ever-increasing, light of the doctrine of evolution. In its onward progress towards the form and proportions of a typical lobster it is thereby found to pass through conditions that in former times were regarded as distinct animals belonging to less highly organised groups of the crustacea than the parent animal.

Thus, when liberated from the egg, the little crustacean, designated a "Zoea," has no abdominal appendages, and swims through the water by means of the external branchlets, or "exopodites" of its thoracic limbs, and in this respect resembles the so-called Opossum Shrimp (*Mysis*) referable to the order Schizopoda. This condition is maintained through several successive skin-castings, or ecdyses, the abdominal appendages, or swimmarets, however, gradually developing, and the thoracic swimming organs becoming simultaneously reduced. At or about the sixth cast these last-named structures have entirely disappeared; the little animal swims through the water with the aid only of its abdominal swimmarets, and is to all intents and purposes a small prawn (*Palæmon*). The internal elements, or "endopodites" of the primarily bifid thoracic limbs have, meanwhile, developed into true legs, so that, after the manner of a prawn, the young lobster can either walk upon the ground or swim in midwater. It is with the next ecdysis only that the animal becomes a typical lobster, restricted to an ambulatory mode of existence, or capable of spasmodic translation only through the water in a backward direction through the flapping action of its spreading tail. Did we trace back the developmental phases of the lobster to a period before it had left the egg, we should find that for a while it represented a much lower type than an Opossum shrimp, or prawn, it having then but three pairs of jointed appendages, and corresponding in this respect with what is known as the primitive larval or "nauplius" condition of all crustacean life.*

Interesting as these developmental phenomena of the lobster are shown to be, the chief object of my bringing them before your notice is to impress upon you the fact that, during the first three or four weeks, at least, of its existence, the lobster is so small and helpless, and so exposed to surrounding perils, that a very infinitesimal percentage only of each liberated brood can hope to run the gauntlet of its numerous enemies, and to settle down to the bottom of the sea as an ambulatory lobster. Gregarious shoals of full-grown fish, such as herrings, atherines, and sand-eels, subsist almost exclusively upon pelagic crustacea, be they the adult phases of smaller species or the larval conditions of larger types, such as crabs and lobsters ; while the young of almost every fish that swims, in addition to a host of marine invertebrate animals, are addicted to a similar diet. The risks that a lobster runs during the first few weeks of its infancy, are, in fact, as great, or, indeed, greater than those encountered by a young salmon, in its native streams, during its egg and "alevin" conditions.

* The several growth-phases of the common lobster as here described have, on all substantial points, been likewise independently observed in France by M. Gerbe, in Norway by Professor Sars, and of the American variety by Mr. S. J. Smith.

Now all present will, I think, admit that that day on which it was found possible to protect and rear these infant salmon, until they were fit to shift for themselves and be turned into the river, constituted the turning-point in the downward career upon which our salmon fisheries, up to within a comparatively recent date, had entered. But for this discovery, that the eggs and young of the Salmonidæ might be artificially reared and protected, and in spite of all rules and regulations concerning a close time and the protection of undersized fish that had been established, our best salmon and trout streams would by this time have been literally ruined.

Now, gentlemen, the very important proposition that I have to submit to your consideration is, that the eggs and young of the lobster are, as compared with the salmon, equally susceptible of artificial cultivation, and you will agree with me, I think, if I can substantiate this statement, that the resuscitation and restocking of our exhausted lobster fisheries are brought within, at least, a measurable distance of accomplishment. Nothing short of evidence of the most practical description will, I am aware, assist me in substantiating the position I have undertaken, and such evidence I will now place at your disposal. At many of the large public Aquaria with which in former years I have been associated as naturalist, berried lobsters have brought forth their progeny in the tanks. On most of these occasions the fate of the little lobsters has been to either perish for want of suitable nutriment or to be eaten up by the other fish. Notably, however, in the year 1875, at the Manchester Aquarium, I observed of a newly-hatched brood that they assembled like a cloud of gnats and fed freely upon the finer particles of minced fish thrown into the water as food for the ordinary occupants of the tanks.

It was the observation of this phenomenon that suggested the possibility of rearing them artificially. Examples were accordingly removed, placed by themselves, and fed at regular intervals with the food for which they had displayed a partiality, the upshot being that a considerable number of them were reared through the several metamorphoses previously described, and until, in fact, they had become fully formed ambulatory lobsters measuring about one inch in length. Specimens of these little lobsters thus artificially reared I have the honour to submit to you.

It remains for me to state that the experiment, thus brought to a successful issue, was accomplished in the roughest and rudest manner. The little animals were merely placed, a number together, in glass jars having each a capacity of about one quart, the sea-water contained in them being simply changed each morning. Such crude efforts on a small scale being rewarded with success, it is not only probable but it may be maintained as a reasonable and logical deduction, that the culture of young lobsters on a very much larger scale, and with the aid of all those perfected appliances and experiences, that have been brought to bear upon the hatching and rearing of Salmonidæ and other fishes, would be easy of achievement. The period during which the young lobsters would require attention, dating from the time of their exclusion from the egg until they attain to the ambulatory state, is represented by an interval of but a month or six weeks, and the amount of food each individual lobster will consume in that time does not exceed one or two ounces. The ambulatory state arrived at, the little animal, though not exceeding an inch in length, is perfectly fit to shift for itself, and, like a young trout or salmon of the same size, on being consigned to the water immediately goes to the bottom and seeks to hide itself beneath the stones or any suitable shelter that may present itself.* The rearing of lobsters in thousands instead of in tens or units would, it is needless to assert, be but a matter of augmented apparatus, and what the results would be upon our depopulated lobster grounds if several thousands, or rather millions, of such young animals could be turned out upon them annually, those are best qualified to record a verdict who have already had practical experience in the cultivation of Salmonidæ.

Certain details respecting the suggested culture of lobsters on an extensive scale, and having such a practical end in view as the restocking or improvement of our home fisheries, may now be proceeded with. In the first place, the simplest method of obtaining the young lobsters to be reared is doubtless to keep the berried hens in suitable ponds or tanks until the young are liberated from their eggs. This process, though a sure one, necessarily entails the feeding of the adult fish for a period of several months while their eggs are ripening, and this expense, in my opinion, might be avoided. As explained in an earlier paragraph of this Paper, the relationship maintained between a female lobster and her eggs is a purely mechanical one, for the purpose of securing their protection, aeration, and freedom from extraneously derived substances until the young are hatched. Now all these conditions could be as efficiently secured by an artificial system of culture, almost precisely identical with that which has been brought to bear so successfully upon the cultivation of the eggs of the Salmonidæ and other fishes. The eggs of the lobster might be similarly spread out upon trays or grids, allowing the free percolation of well-oxygenated water, and intelligent supervision being at hand in the same way to remove all dead examples or other deleterious matters. Or nature itself would be yet more nearly imitated if the groups of eggs, numbering many hundreds, as attached to the swimmarets of the parent, were bodily removed, and by some simple device suspended in grape-like clusters within the midst of the circulating currents. The young lobsters being hatched, they will be found to thrive best in deeper receptacles where they will have abundant room to swim. The font-like rearing troughs introduced by Mr. Oldham Chambers, F.L.S., the goblet-shaped glasses utilised by the Canadian pisciculturists, but more especially the larger glasses on the "intermittent syphon system" and other hatching receptacles for floating spawn made use of by the United States Fisheries Commission, may be cited as being particularly suitable for lobster rearing.* Feeding the young brood is obviously a mere matter of mechanical detail, finely-minced fish or mussels being the most convenient pabulum. Whatever is decided on, due attention must be paid to the food being supplied abundantly and regularly, otherwise they will fight and devour one another. The well-known pugnacity and reputed cannibalistic tendencies of lobsters and other crustacea has been supposed by some to present an insuperable obstacle to the cultivation of lobsters in quantities. Where, however, an abundant supply of other food is forthcoming it will be found that they prefer it to their own species; and I need hardly remark that cannibalism where animals are reduced to a state of starvation is not, as a moral attribute, monopolised by the crustacea.

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* Although not frequently obtained close to shore in this very early ambulatory condition, my friend Mr. Henry Lee, F.L.S., tells me that he has, many years ago, taken such little lobsters, having an average length of from one to one and a half inches, in the neighbourhood of Shanklin, Isle of Wight.

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* I here take the opportunity of acknowledging the kind courtesy shown me by Mr. Earle of the United States Fisheries Commission in introducing and explaining to me the very complete collection of hatching and rearing tanks exhibited on behalf of the United States Government in their department of the International Fisheries Exhibition. Such inspection, it may be added, resulted in that gentleman's concurrence with my own opinion, that the receptacles on the "intermittent syphon system" were especially adapted for lobster culture.

Once reared through to the ambulatory condition the little lobsters are fit for liberation in their native element, and here care must be exercised in the choice of the ground upon which they are turned out. That of a flat sandy nature affording no shelter, and where they would be speedily sought out and devoured by their numerous enemies, should be avoided. Rocky ground, which is their natural haunt and from whence, as is well known, the most abundant supply of lobsters is derived, is that on which they should be set free. Arriving at the bottom of the water they will, as previously observed, immediately seek for a suitable crevice wherein to hide themselves, and this having been met with it is adopted as their permanent abode, to which they will constantly retreat after their sorties in search of food, which are usually made at night. This selection by lobsters of a definite dwelling place is a well-known circumstance to fishermen and others practically acquainted with the habits of marine animals. It may be cited as an additional encouragement to those who may be tempted to embark upon the industry of lobster culture, since the lobster being a sedentary or home-staying type, those who sow the pasture lands of the sea with this particular crop may likewise from the same ground reasonably hope in the process of time to reap the fruit of their labours.

If the scheme here proposed of rearing both the eggs and young of the lobster should be found capable of practical application, it may be hopefully anticipated that a check will at length be given to that most pernicious practice of utilising the spawn or berry of the lobsters for culinary purposes. Tens or even hundreds of millions of lobster eggs, each egg representing a potential lobster, are thus wastefully consumed in this country year after year. The late Mr. Frank Buckland, who was one of the most strenuous protesters against this wanton destruction of lobster spawn, thus writes, in the year 1875, in his "Report upon the Fisheries of Norfolk"—"It must be evident that the destruction of so many lobsters in the form of eggs must of necessity greatly tend towards producing the scarcity of lobsters which is now being felt in the London and other markets." As an illustration of the quantity of lobster eggs that are used by the cooks who must and will have it for colouring fish sauces and for decorative purposes, it will be found stated in the same Report that—no less than from 14 to 18 lbs. of lobster spawn have been supplied by a single collector in this manner for culinary purposes during the two months of April and May. The number of eggs contained in this mass of spawn amounted at the very least, in Mr. Buckland's estimate, to 1,720,320, and this figure represents, it must be borne in mind, but an unimportant fraction of the sum total that is consumed for a like purpose throughout the realms of the United Kingdom. Now, what would be thought of the individual who advocated or carried into practice the utilisation of the eggs of the salmon for a similar purpose* : would any term of opprobrium that might be levelled against him be considered too strong or any punishment too severe? And yet, precisely such a disastrous policy is in the case of the lobster freely sanctioned and approved, without let or hindrance, every day in the year. A remedy for this long-acknowledged evil has been suggested on many sides in the form of the proposition that the sale of berried lobsters should be made illegal. Such a suggestion, however, if carried into practice, could be easily evaded by the fishermen, who would simply remove and throw away the spawn before bringing the animals to shore. If, however, the cultivation of lobsters from the egg should be developed as a practical industry, there is every reason to believe that a stop would be speedily put to the wholesale destruction of their eggs that is now being carried forward. If the expression of public opinion should prove insufficient to bring about so desirable a result, the supply of eggs at present only flowing to the saucepans of the cooks might be diverted to the hatcheries of the cultivators through the offer, if need be, of a better price than they are at present commanding as a mere condiment for sauce. As a matter of fact, it is simply for its decorative effect and not as a flavouring agent that the article is in such demand by our West End *chefs*, and surely in these days of discovery and invention the chemists might come to our aid with some harmless and yet equally brilliant pigmentary substance, that being utilised as a substitute would remove all further necessity for the present lamentable destruction of embryo lobsters.

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* I am informed, on good authority, that salmon spawn, cooked and eaten after the manner of green peas, is not an altogether unknown delicacy in certain parts of Ireland.

The question that remains to be considered is as to whether lobster culture in the manner here suggested might be prosecuted with pecuniary advantage by private individuals, or whether it is a subject adapted only for the intervention of the State. It is certainly scarcely to be anticipated that many private persons will be found sufficiently philanthropic to undertake the restocking of our exhausted lobster grounds for the benefit of the fishing commonwealth. Nevertheless, there are many large landowners with estates bordered by a rocky coast-line, who would doubtless welcome the opportunity of thus placing at their tenants' disposal the means of materially augmenting their source of income. To those among this category who have had practical experience in trout and salmon hatching, this subject of lobster culture might be especially recommended upon several grounds. The routine in either case will be very similar, while a large portion of the apparatus constructed for salmon hatching might be utilised for lobster culture, and moreover would be empty and available for use just at the time when the lobsters commence to spawn.* To other nations besides our own it may be anticipated that this proposed plan of hatching and rearing lobsters would be found advantageous. By way of illustration, reference may be made to the arduous efforts that were instituted in the United States, and notably by Mr. Livingstone Stone, to transport the lobster across the continent from the Atlantic to the Pacific seaboard where it was previously unknown. Experiments in every instance were made with adult lobsters, involving the employment of bulky apparatus, great expense, and many failures before even a small amount of success was obtained.* If, in place of this, recourse had been had to young fry that had arrived at the ambulatory state, and were just ready to transfer to the sea, thousands might have been successfully transported in less space and at less cost. Better results still would, probably, have been arrived at if the eggs only, detached from the females, had been carried across to the Pacific coast, and a hatchery for their development and the rearing of the fry been established contiguous to the shore on which it was proposed to set them free.

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* Mr. Frank Gosden, pisciculturist to the Duke of Wellington, has imparted to me within the last few days a very interesting piece of information that bears upon the subject of lobster culture. He tells me that for some time past, during the summer months, he has with great success devoted the troughs utilised in winter and spring for hatching trout, to the rearing of newly-hatched freshwater crayfish. Lobster rearing on the same principle he considers would be equally feasible. It is perhaps desirable to mention here that the river crayfish has not, like the lobster, a free-swimming or Zoea phase, but enters upon the ambulatory condition immediately it leaves the egg. The treatment required for the two animals would therefore not be precisely parallel.

Although practical attention has not hitherto been directed to the artificial culture of lobsters from the egg on the system here advocated, experiments have been made both in this country and in France and Norway to establish parks and enclosures for the cultivation or storage of the adult animals. In all these cases, however, so far reported, the results obtained have not been encouraging, the outlay required to keep up the supply of food leaving no margin for profits. It is still, nevertheless, an open question whether or not in certain favourable situations where a food supply could be obtained at a minimum cost, the culture of adult lobsters might not be developed into a remunerative financial enterprise. It may be remarked in this connection that fish condemned as unfit for human food is, to the average amount of one ton per day, sent away for destruction from the metropolis of London alone. Now the lobster, as is pretty generally known, is particularly partial to stale fish, and when supplied with fresh food in the tanks of an aquarium, is, unless greatly pressed by hunger, in the habit of burying it until it has arrived at an advanced state of decomposition. It is evident that a very small portion of the fish above referred to that is destroyed daily in this metropolis, and which might be had for the cartage, would suffice to feed many thousand lobsters, and might be converted into that highly esteemed crustacean at a considerable profit to the cultivator. The object of this Paper is not, however, to advocate the cultivation of adult lobsters, but expressly that of establishing hatcheries for the development of the ova and young, for the purpose of replenishing or restocking our much exhausted fisheries.

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* According to the latest Report, p. 10 of the Descriptive Catalogue of Economic Crustacea, &c., of the United States, in the Great International Fisheries Exhibition, London, 1883, the attempts made to transport lobsters to the Californian coast have been entirely unsuccessful. Such failure may probably be attributed to the small number of individuals that ultimately survived and were distributed at their port of destination.

In this direction it may, I think, be predicated that lobster hatching and rearing is hereafter destined to occupy a prominent position in the science of pisciculture, and if conducted with any approach to the perseverance, intelligence, and ingenuity that has been already concentrated upon kindred branches of the fishing industry, cannot fail to achieve an equally signal and complete success.

DISCUSSION.*

Mr. Kenneth Cornish, after some remarks on the value of fish as food, having particular reference to a paper read by Sir Henry Thompson at a previous Conference, was going on to describe an improved method which he had adopted for cooking fish, when he was reminded by the Chairman that the special subject of the Conference that day was crustaceans. He said he would not detain the meeting, but had also devised a method for preserving fish in the form of powder, by which the whole of the nutritive constituents were preserved, including the albumen.

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* The following discussion and motions carried refer in part to a Paper that was read the same afternoon by Mr. T. Cornish, on the subject of Crustacea generally.

Mr. BIRKBECK, M.P., then moved a vote of thanks to Mr. Cornish and to Mr. Saville Kent for their interesting papers, which had contained a deal of information which was probably new to many persons present. Mr. Cornish had told them of a remarkable fishing ground on the coast of Cornwall, which might be safely fished without any restrictions, whilst on the other hand Mr. Saville Kent had given statistics proving that the supply of lobsters was apparently decreasing rapidly. He might say that on the coast of Norfolk there was a small lobster and crab fishery on a ground of about fourteen miles in length by three to four miles in breadth, which many years ago was a very productive fishery, but unfortunately the practice of breaking up small crabs for bait, and also the practice of sending to market berried hen lobsters, was carried on to such an extent that the fishery was reduced really to nothing. He was asked to institute a Board of Trade inquiry, and the late Mr. Buckland and Mr. Spencer Walpole came down and held it; the result being that an order was passed putting a stop to the capture of berried hen lobsters and also the soft crabs, and the fishermen were strongly advised to stop the breaking up of small crabs for bait. That order was in force for three years, and when it expired, which was on the 1st of February this year, another inquiry was held by the Board of Trade, under the supervision of Professor Huxley. The evidence which was given, not only from the fishermen, but the salesmen, was so convincing as to the effect of the order being to increase the supply to four or five times what it was previous to the order being passed, that the Board of Trade had now passed an order putting a stop to the practices which were in vogue for ten years, and the fishermen had made up their minds that they would endeavour to get a local Act passed to put a stop entirely to the breaking up of small crabs. That showed what could be done in a small district, and he hoped it would be carried out throughout the country.

Mr. BRADY had much pleasure in seconding the resolution. He did not know that there was any question more interesting than that of crab and lobster fisheries, unless it was the artificial cultivation and production of salmon and trout. He quite agreed with Mr. Saville Kent on the great importance which would be derived from the artificial cultivation of these fish in the same way as salmon and trout, but he did not follow him so far as to think that the same instruments or conveniences could be used for one as were used for the other, inasmuch as one must be carried on near the sea, and the other far inland. With regard to the crayfish, he agreed with him it could be done, but that was only a matter of detail. He feared, however, it would be like other matters which were for the public good, that it would be hopeless to expect private individuals to undertake it. This subject, along with the artificial propagation of the better species of fish, and, probably, eventually they might come to that, was a matter which concerned the State more than private individuals, and he thought it would be found very difficult to find private gentlemen so scientific as to go to the very large expense which would be required, without any certainty of recouping themselves or obtaining interest on the money.

The resolution was carried unanimously.

Mr. CORNISH, in reply, having thanked the meeting, said he would make one remark on Mr. Saville Kent's paper, that was with regard to the use of the berry of the lobster. If they could only bring it home to the minds of cooks that the berry of the lobster was absolutely tasteless, and if it had any taste at all it was a slightly unpleasant taste of iron, and that, therefore, it was only valuable as a colouring matter, there might be some hope of putting a stop to the present practice of using it for sauce. He then proposed a vote of thanks to the Chairman for his kindness in taking the chair. He had known him for some years as a practical fisherman, and he was sure a better chairman could not have been selected.

Mr. SAVILLE KENT seconded the motion, which was carried unanimously.

The CHAIRMAN said he could assure the Conference it had given him great pleasure to be present that day, because this question of crustaceans was one which must interest every one. The lobster and crab fisheries had always had a peculiar interest to him, because it was essentially a fishery for poor men. The crabbers generally worked with their own hands alone, and in their own little boats, and were exposed to almost as hard work as any toiler of the sea, so that anything which could be done to protect their interests, or increase the supply of this fish, would be most valuable to the fishing community. With regard to what had been said about legal interference, he might say that in 1877 an Act of Parliament was passed to a certain extent protecting crabs and lobsters, by prohibiting the sale of undersized fish.

The question of berried hens, as they were called, was very much discussed when that Act was passed, and he took a great deal of trouble to get information and evidence with regard to them. It was not the cooks alone who were to blame in causing berried hens to be sent so largely into the market, the fishermen themselves doing it, because the lobsters having berries on them were in as good condition for eating as at any time in the year, and if the sale of berried hens were prohibited, as Mr. Saville Kent remarked, and as he had heard from the fishermen themselves, they would simply evade the law by brushing off the berries. The size of crabs was another question which was very largely discussed, and, as Mr. Birkbeck could bear him out, the people in Norfolk, where crabs were not as large as on the south and west coasts, were in favour of a larger size being named than that which was placed in the Act, viz., 4¼ in. across the crab's back. That was such a tiny thing, and contained so little meat, that a very small extension in the size would produce much more valuable food for the table, and the fish would increase its species in an enormously large proportion. With regard to the district which Mr. Cornish had spoken of, where fishing could be carried on for over 200 square miles without doing any harm, he would point out that there was a great natural protection existing there, for that fishing ground was exposed to all the tremendous rollers of the Atlantic Ocean, so that it could not be fished so constantly and incessantly as inshore crab fisheries, and those places around the shore where it was acknowledged on all hands that crab and lobster fisheries required protection.

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International Fisheries Exhibition

LONDON, 1883

OYSTER CULTURE

AND

OYSTER FISHERIES

IN

THE NETHERLANDS

BY

PROFESSOR HUBRECHT

LONDON
WILLIAM CLOWES AND SONS, LIMITED
INTERNATIONAL FISHERIES EXHIBITION
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1883

International Fisheries Exhibition.

LONDON, 1883.

CONFERENCE ON JUNE 29TH, 1883.

OYSTER CULTURE AND OYSTER FISHERIES IN THE NETHERLANDS.

Lord HENRY SCOTT, M.P., took the chair, and in introducing Professor Hubrecht, said this was a subject in which he felt deep interest, and had had some practical experience. Being the owner of a property on which there was a native bed of oysters, this had drawn his attention to the subject, and the importance of, if possible, doing something to restore the stock of oysters upon it, which he found to be deficient. The stock of British oysters was acknowledged to be daily diminishing, there not being enough to meet the ordinary supply, so that recourse was obliged to be had very largely to foreign oysters, and even they were not sufficient to supply the demand for this excellent article of food.

Professor HUBRECHT spoke as follows :

About six weeks ago I had the advantage of being present at a lecture "On Oysters and the Oyster Question," which was given at the Royal Institution by one of your most eminent biologists, Professor Huxley.

It would be very presumptuous on my part to go over the same ground once more, after that very able discourse has come under the notice of you all, and I wish to limit myself to a few statements concerning the oyster fisheries and oyster culture in the Netherlands.

Time was when oysters from natural oyster-beds were very plentiful with us. These beds were situated, partly in our Southern province of Zeeland, partly towards the North in the inland sea which we call the Zuyderzee, at the spots indicated on the Map. The oysters were brought to market in Amsterdam and were partly exported to Germany at a price which bears no comparison at all with what is at present paid for them.

This having been the state of things a good many years ago, it is a pity that we have to recognize the fact of one of these natural beds being nearly destroyed. There is no serious doubt but this destruction has come about by over-fishing. The few oysters that are left are only worth the notice of the Nieuwe-Diep fishermen in the summer time when they are not employed in any other fisheries, and even out of their number only a few pay regular visits to those parts of the Zuyderzee where oysters may happen for the moment to be just a little more numerous than usual. There is no regular oyster trade in that part of the country.

The oyster trade with us is for the present concentrated in the province of Zeeland, where, as was noticed before, a second natural oyster-bed of some extent has existed. This bed was very fast on its way towards extermination and would certainly have followed in the wake of the Zuyderzee beds, had not oyster "culture" at the right nick of time stepped in and replaced "oyster fishing." The already impoverished regions have since made rapid strides towards their maximum of productivity, and it is from them that the large numbers of so-called Dutch oysters or Dutch natives, which if I am not wrong are high up in the scale of merit according to the verdict of London palates, are derived.

It was in 1870 that this change of system was effected. Up to that year fishermen from the small village of Yerseke and from other hamlets round the so-called eastern arm of the River Schelde regularly fished and dredged on this bed in the five winter months (October—February). There was a close time for oyster fishing (during which period it was strictly prohibited) of no less than seven months, from March 1 to October 1. Still it was generally accepted that notwithstanding these measures the bed gradually became impoverished.

About the same time that it was decided upon to no longer allow public fishing on these beds but to give them into the hands of oyster-culturists, another important change had been effected in the geographical situation of the oyster-beds. A railway-dam had been constructed across the eastern arm of the Schelde where it was narrowest, and this practically changed the nature of its waters. It now became, as you will see from this map, a deep inland bay, instead of being one of the arms of the Schelde delta through which part of the fresh water from this river could flow towards the German Ocean. This change has of course affected the salinity of the water, and it may be safely inferred that this has not remained without influence on the oyster-beds of the eastern Schelde and their productivity.

The first impulse towards prohibiting public fishing on the so-called Yerseke oyster-bed was given by private gentlemen, who in 1867 had visited the Arcachon oyster regions and who applied to government for aid towards an investigation of the condition of the Yerseke-bed. The result was that in 1870 and 1872 Government, or rather the Minister of the Finances under whose control are also the fishing waters of the country, withdrew the Yerseke oyster-bed from public fishery and leased it for purposes of oyster-culture to private individuals, after having divided it into plots varying in size from 12 to about 150 acres. The rent was to be paid yearly, and the time up to which it might be retained for the same rent was 15 years, facilities being offered to those who wished to give back their allotted plots before the expiration of the 15 years' term. In 1885 the whole of the Yerseke oyster-bed would come back to Government and new agreements would then be decided upon. As this period is now rapidly approaching it was wisely decided upon by Government not to wait till 1885 before re-letting the bed, but to do so at least three years before the expiration of the present leases. So last year this new leasing took place, and the same 7720 acres which form together the Yerseke oyster-bed and which have been leased from 1870 to 1885 for a yearly rent of about £1720, will in 1885 bring into the Exchequer a yearly amount of £28,765. These figures speak for themselves and go far towards demonstrating that oyster-culture in the regions we are speaking of is a success. The new lease runs for thirty years, with the right on the part of the lessees to give up their allotments every five years.

The extraordinary increase in value just alluded to of the different portions of the oyster-bed, has not similarly affected all portions of that area. I will give you figures to demonstrate this; but I must first call to your mind, that in the practice of oyster-culture, certain areas are principally devoted to "growing" the oysters, others to collecting the spat, and that the value of a certain area is principally determined by the intrinsic qualities which it is supposed to possess for the one or for the other of these operations.

The collection of the spat essentially consists in the process of bringing out into the sea-water tiles, like these I have here on the table, covered by a layer of chalk, which is afterwards easily removed, together with the young oysters adhering to it.

These tiles are brought out in millions at the time when the oyster spat is expected to be most plentiful. If brought out too early, they get covered with a layer of earthy deposit, or lose the roughness of their surface, and the spat will not then fix upon them; if brought out too late the spat may have altogether disappeared for that season. It is thus a very important question when and where to deposit the collecting tiles. Up to the present, oyster-culturists have been guided mostly by empirical notions, tradition and experience having decided what portions of the sea-bottom were most fertile for the collecting of the young. Theoretically this question is dependent on circumstances which are, indeed, complicated. It must first be asked, where are the oysters that furnish the spat? secondly, how long does this spat swim about independently, before fixing itself? thirdly, what is the influence of the currents in the vicinity of the mother oysters upon the distribution of the spat over a certain area?

It has been the object of a series of investigations planned by the Direction of the Dutch Zoological Station, of which I am a member, to try and get definite and reliable facts concerning these movements of the spat. I am sorry to say, that in this respect our results up to the present moment are rather scanty, although we are continuing our exertions. One fact is generally accepted, viz., that exceptionally good localities for spat collecting are those where there is a strong current of fresh sea-water at each tide in the immediate vicinity, and where, at the same time, this current is broken by headlands or other causes, so as to produce counter-currents of much reduced intensity. The spots where these counter-currents occur are very much valued, as are also those deeper pits here and there found in the sea-bottom, above which a sort of whirlpool is apt to occur. It would seem that in both these cases, the spat is more easily deposited, is, so to say, precipitated, on the collecting-tiles or other substances (shells of dead molluscs, &c.), to which it can adhere. Localities answering to the above requirements are found on the spots I will indicate on the map.

In order now further to bring before your mind how the value of one locality above another for this and other purposes of oyster-culture, appears to be gradually established by experience, and is, indeed, recognized by those interested in this industry, I have promised to give you a few comparative numbers of the sums for which the same plots were leased in 1870, and will be so from 1885 forwards :—

Allotment No. 162, size 12 acres, was leased—

			In 1870 for	1*s.* 8*d.*	a year ;	will be in 1885	£202	a year.
No. 163	12	ac.	„	1*s.* 8*d.*	„	„	£227	„
„ 164	12	„	„	13*s.* 4*d.*	„	„	£252	„
„ 176	12	„	„	£22 10*s.* 0*d.*	„	„	£508	„
„ 220	120	„	„	£25 18*s.* 0*d.*	„	„	£33 15*s.*	„
„ 138	12	„	„	£18 10*s.* 0*d.*	„	„	£762 10*s.*	„

Others have gradually come down in the market, as for example—

No. 280. 24 acres brought in 1877, £45 16*s.* ; in 1879, £1 10*s.*
„ 415. 18 „ „ £2 1*s.* ; in 1882, 10*d.*

The fluctuation is, as you see, indeed considerable, and only rivalled by that mysterious fluctuation of spat which, in the breeding season, is carried to and fro at each turning tide, all through the basin of the eastern Schelde.

A question which we were also eager to answer in continuing our investigations at the Zoological Station, was this: From whence is the spat that occurs in such myriads on the Schelde essentially derived? The interest of this question was increased by the fact, that among the oysters which were dredged on the cultivated beds, the number of ripe specimens carrying eggs, was very rare. This was partially explained by the fact, that the oysters are generally collected and sent into the market *before* the female generative products have attained their full maturity. However, this circumstance made it all the more wonderful that still the so-called *fall* of spat had, during the last ten years, been on the whole so considerable, the unproductive years being generally more the consequence of other circumstances than of the absence of young oyster larvæ at the right season.

It must, moreover, be specially mentioned, that after the Yerseke bed had been withdrawn from public fishing, no obligatory close time for oyster-fishing was ever prescribed. The lessees could dredge for their oysters at whatever time of the year they liked. That they did not generally do so in summer was, in the first place, for fear of disturbing the growth, the delicate edges of the shell being at this period more particularly liable to break; and secondly, because the oysters are found to be less palatable at this time of the year. I hardly presume that they were already convinced of the truth of Professor Huxley's view, which he repeated in his lecture above alluded to, and which I have no doubt is the right one, that a close time for fishing on oyster-beds may be very serviceable; but that there is absolutely no reason to see why it should be more so *during* the spawning time than either *before* or *after.*

The great thing appears to be to leave a fair portion of the oysters on or around a natural bed, wholly undisturbed for a series of consecutive years. Now such an arrangement was never carried out *intentionally* on the Yerseke bed, every portion of it and of the whole eastern portion of the Oosterschelde having been leased for purposes of oyster-culture.

Continuing our investigations as to the source from whence the spat might be naturally derived, we were thus led to suppose that natural beds of a certain extent were present in the western portion further seaward. Dredgings were undertaken by means of a government steamer, but they gave a negative result, and this coincided with what had already been told us by fishermen, i.e., that no such natural beds existed.

One day, the idea occurred to us, that we were looking the wrong way, and that what we were searching for was much closer to us than we expected.

The fact is, and hitherto I have not yet mentioned it, that a regulation which has been rather strictly attended to, and which had originally been proposed by those government departments that are in charge of the maintenance of the dykes defending the country against invasions from the sea, runs thus : *it is not allowed to use dredging implements of any description for the capture of fish or mollusks within a line of* 500 *meters distance from the coast.* The reason of this prohibition was that the foot of the dykes running out into the sea is in several spots protected with specially constructed stone defences which might be seriously damaged by dredging, and might thus weaken the dykes, endanger the land behind them, and, at all events, necessitate expensive repairs. It was the more easy to enforce this regulation because dredging for oysters within this 500 meter area, wherever the stone-works had been constructed, was attended with great danger of losing the dredge, as it easily got entangled in one way or the other.

Now to this band of nearly a quarter of a mile in width which surrounds the Schelde basin on all sides, our attention was more especially directed. A diver was sent down at numerous different points to make the explorations as thorough as possible. It was thus brought to light that really, wherever the stone-works alluded to stood out on the sea bottom, which at those localities rapidly sloped down towards deeper water, there was a more or less numerous, at some spots even a very profuse crop of oysters of all ages, which, in consequence of the regulations above mentioned, had never been disturbed and bore the evident traces of this. When at a few localities no oysters were found on the submarine stone-works it was to be ascribed to these having been newly constructed or repaired, or to their having been covered over with sediment.

The results of these diving operations were mapped out and are shown in the diagrams I have before me. The long band-like patches of oysters follow the stone-works, and both to seaward and towards the land, where a muddy bottom is prevalent in their immediate vicinity, no oysters occur.

The localities that have hitherto been thus investigated are shown in this map, and I may fairly infer that the continuation of our researches with the diving apparatus which are contemplated also in this summer, will enable us to trace the confines of this natural oyster-bed with precision.

It is hardly doubted by any of us, nor by the professional oyster-culturists themselves, who have a more direct interest in the productivity of the eastern Schelde, that here, indeed, we have before us the principal source from whence the spat is yearly for the greater part derived, and everybody appears to be anxious to maintain the present state of things and to have the prohibitory clause against fishing within the 500 meter area most strictly observed.

The investigations concerning the oyster questions which were carried out by means of the transportable Zoological station, and which have just been alluded to, also extend in other directions. The anatomy of the oyster has been carefully inquired into by Dr. Hoek, and I have before me his elaborate treatise with numerous illustrations. The embryology of the oyster has been investigated by Dr. Horst, who is still continuing the researches, part of which are already published. The physical circumstances are similarly inquired into, and series of observations concerning temperature and salinity of the water are repeated three times a day at different points of the Schelde.

In the course of this summer our attention will be more especially directed to the process of fixation of the larvæ when at the end of their free life they settle down on some hard substance where to develop into a full grown oyster. To get hold of the largest number of young oysters, fixed in this way to transportable apparatus, is a most important object to all oyster-culturists, and this problem is before them once every year at the breeding season. All the different forms and shapes of collecting apparatus, some of which are here on the table, and which you will find in great variety in the different departments of this Exhibition, tend to the same object. Still the process of being obliged to bring these out into the open sea, hoping that the invisible spat may fix down upon them in great quantities, may to a certain extent be compared to a man trying to catch birds by throwing his hat at a passing flock.

In order to bring this matter within the reach of man's voluntary interference, different attempts have been made to let the oyster give off its spat in an enclosed space where it might be collected at leisure on the apparatus which was deposited in the same enclosure. Such experiments have—in our country at least—always led to negative results. However, we are not certain that they were taken with the necessary precautions, the water being only very rarely and partially changed. The consequence of this must have been extensive mortality of the spat by the water becoming de-oxygenated, and loss of spat at those —whenever so few—occasions on which the water was partially renewed.

In our experiments we wish by all means to eliminate such sources of error. We have had the free disposition given to us, during the whole time of the experiment, of one of the largest oyster parks. It is represented in this figure. At these points there are inlets for the sea-water that can be opened and shut, and the volume of water forming the oyster park is divided by smaller dykes and by wooden enclosures into several compartments.

One of these has been entirely separated from the rest, and is specially devoted to the purpose of our experiments. In this separated portion, here indicated by dark blue, and which has a superficial extent of about a quarter of an acre, about 10,000 mature oysters are about to be deposited, the floor of the compartment having been covered by apparatus for collecting the spat. As long as the breeding season has not yet so far advanced that the spat is set free the water is changed with every tide. In the meantime we have here put up a steam engine, and by this we intend to bring about artificial oxygenating of the sea-water the moment the spat makes its appearance. We then shut all the exterior inlets of water once for all and continue our experiments during the rest of the summer with the water at that moment contained in the park. In this way there is—1st, no possibility of the spat escaping. 2nd. No possibility of spat being introduced from outside, which would interfere with the reliability of eventual results.

To make a comparative experiment with different methods of aerating the sea-water we have divided the space here indicated in two halves. In the anterior portion a revolving axis with blades attached to it causes a continual current and at the same time introduces a certain amount of air. In the posterior portion compressed air is introduced into the water by a very large number of small orifices through which it is continually pumped, and from whence the air-bubbles must ascend towards the surface.

In this way we hope to provide our young oyster larvæ with a fair supply of oxygen, to the absence of which we ascribe the failure of previous experiments. Nobody can, of course, predict as to whether we shall be more successful, and whether in the breeding season we shall find the different sorts of collecting apparatus we are going to experiment with, profusely covered with spat; but still it was our conviction that we ought to give the question a fair trial, the more so since the experiments of Bouchon Brandely on the French coast have put it beyond doubt that with the Portuguese oyster (*Ostrea angulata*), artificial fecundation and collection of the spat in myriads is quite feasible. The market value of the Portuguese oyster is, however, very low; the oyster has quite a different shape from ours, and is generally considered of a very inferior flavour.

This example, though encouraging, does not, however, admit of the conclusion that we have equal chances of success with *Ostrea edulis*, our north-European oyster. Part of the development of the young of the latter species takes place within the shell; and as this is not the case with the Portuguese oyster, artificial fecundation in the former species would be very hazardous.

For this reason the plan for the experiment has been traced in the way I have just now explained.

I have dwelt at some length upon these experiments because they will bring before your minds the phase at which the theoretical questions with which oyster-culture has to deal have at present arrived.

As to its practical side I am afraid time will not permit me to give you a fair description of the different implements and processes. Moreover, I believe most of you are sufficiently acquainted with them ; and if not, there is no such opportunity as that offered by this Exhibition to study them in full for yourself.

In terminating I must not omit to mention that the favourable results of oyster-culture in the Schelde have directed the attention of government to the re-stocking and the methodic improvement of the Zuyderzee beds on the same plan that has been followed since 1870 for the less over-fished Zeeland bed. As yet these measures are not far advanced, but it can hardly be doubted that in the course of a few years a new source of the prized delicacy we have been considering to-day will there be opened, the natural conditions having on the whole remained the same since the time these beds were so plentiful.

DISCUSSION.

Mr. Fell Woods said when the somewhat imperfect report of Professor Huxley's address at the Royal Institution was published he was impressed with some fear whether henceforth Professor Huxley must not be classed amongst the enemies of the oyster; but the inaugural address he had since delivered to this Conference somewhat re-assured him, because he had indicated plainly that there was a possibility that certain restrictions on oyster-dredging might produce some valuable results. Unfortunately he did not go so far as to say that they would actually produce such results, and so far as he restricted himself he was not quite sure that he had come over to the side of the oyster as against his enemies. He feared he did not place sufficient value on the close time during the spatting period. It was true, of course, that if a large amount of dredging went on during the other periods of the year the effect of the close time during the spatting period could not be so great as it otherwise would be; but in proportion as any oysters were left on the ground owing to the restrictions of close time so must the probability of an increase in the oysters be favoured. Some years since he (Mr. Fell Woods) showed that the period of spatting of the various oysters round the coast was not the same, and in any arrangement which might be made that fact ought to be borne in mind. There were certain periods applicable to certain oysters, and other oysters need not be interfered with during a portion of the period, but might be dredged, their close time coming at a somewhat later period. The restrictions which might be demanded beyond those of a close time were certainly of very great importance; they might be taken as including the question which attached on the one hand to beds within a three-mile limit, and on the other to those which were beyond that limit. But to some extent similar restrictions would need to be applied to both classes. They must apply to the age of the oysters at the time of their removal; also to the parts of the oyster beds which were to be dredged from year to year; to the removal of culch from those beds, and also possibly to the question of some license or fee to provide arrangements for watching and cleaning where required. It would be absolutely impossible on such an occasion to go into the details of this matter, but some years since he published a pamphlet, which he should be happy to submit to Professor Huxley and Professor Hubrecht, in which he had gone somewhat closely into these matters. The reply generally made to any demand for any regulation of oyster fisheries was that so far as concerned the public beds outside the three-mile limit, they would be interfered with by those countries with which we had no fishery convention; but that argument merely showed that we ought to extend our fishery conventions to all neighbouring nations, and he believed that other nations were far more ready to adopt these restrictions than England was. Another matter which was constantly urged was the question of granting what were called "several" fisheries—the allotment of certain grounds to private parties, who undertook the custody and working of them, on a similar plan to that adopted in Holland. To effect this our present arrangements were scarcely what they ought to be, and measures more just to the neighbours should be provided in all these cases, and careful arrangements made with those who undertook them. Another deficiency was that nothing like proper protection against poaching was provided. The wisdom of restrictions and regulations of course depended entirely on their character, and the burden of proof lay on those who advocated them ; but he could not help thinking the reference Professor Huxley made to what he thought was a comparative failure of the restrictive measures undertaken by the French Government, especially at Arcachon, left out of account a fact with which possibly he was not acquainted, viz., that when social or political circumstances appeared to demand it, the fisheries at Arcachon had not adhered to the regulations laid down, but permitted a considerable amount of dredging, in contravention of their regulations. The Paper they had just heard was certainly of the greatest value, and the fairness of spirit with which Professor Hubrecht had brought forward facts which might be used either favourably or adversely to Professor Huxley's view was most noticeable. From long experience of experiments somewhat allied to those now brought forward, he might say that Professor Hubrecht seemed in the main to corroborate views which he (Mr. Fell Woods) had printed some six or seven years ago. The most important point, in his view, was that any questions with regard to regulation and interference in oyster fisheries should be thoroughly discussed again before any decision was arrived at, either to neglect or interfere with them.

Captain ANSON remarked that Professor Hubrecht said these beds in Holland had suffered from over-fishing, and while of course he was willing to accept that, he should have been glad if a little further information on the subject had been given. He would also say that what was sauce for the goose was not sauce for the gander, and that if the oyster beds in the Thames or near the Mersey were allowed to remain undisturbed for two months they would be simply ruined, mudded up and covered with ooze, and the oysters would all be eaten by crabs. He should also like to ask what was the depth of water on the Dutch beds, and also whether, as the result of his experiments, he could say the temperature altered the spatting. He believed that this matter had the greatest possible effect. He would mention one fact which perhaps tended to further the view that had been put forward, namely, that between Cancale and Grenville the French Government had established a permanent reserve, where no dredging was allowed. He went there dredging last year, and the oysters were certainly most numerous ; they appeared to exist in millions. Another fact of some interest was this, that when making some new beds at a place called Arennes, the barriers between two of the beds broke down, and there was a small tramway that went out to the bed which was being constructed. It happened at the spatting season, and when the dyke was finished it was found that so many oysters had adhered to the rails, which had been constantly used by the tramway, that these rails were kept as oyster collectors, instead of being taken up to be used as rails. In Buckland's Museum would be seen a specimen of a flat iron covered with oysters, and, as Mr. Buckland remarked, when the oysters were in a sticking humour, they would stick to anything, and if the washerwoman who used the flat iron had been at the bottom of the sea, they would have stuck to her.

Capt. AUSTIN said he represented a large oyster company which had large beds at Whitstable, and also in Ireland and Scotland. He should second the suggestion of Mr. Fell Woods that there should be discussion on this oyster question, so that some practical conclusion might be arrived at. But as far as he gathered from Professor Hubrecht, he said it was nothing but the old oysters that bred, whereas at Arcachon they dredged every old oyster off the ground, but would not allow the small oysters to be taken. With regard to close times he quite agreed with Professor Hubrecht that no kind of restrictions would do any good. A little fact was worth a good deal of theory. They had a large bed in Scotland where no oysters were dredged for five or six years, and a boat could go there and catch 2000 in a day, which any one would agree was a fair sprinkling of oysters, but there was no vestige of spat to be seen in the place of any sort. That was entirely contrary to the over-dredging theory. On the beds of Whitstable, which were about two miles square, there were from 25 to 30 millions of old oysters, but there had practically been no spat there since 1858 or 1859. There was a little, of course, every year, but nothing to speak of. If the over-dredging theory were right, why was there no spat there? Two years ago there was a large fall of spat, but, probably owing to the cold August, it disappeared and died off after getting to about the size of peas. In Ireland the Fishery Commissioners closed their beds absolutely for three years, but at the end of three years the fishermen could not catch as many oysters as they were catching when the beds were closed. The only fact that the over-dredging theory had to go upon was that the oysters were not there, and of course it might be said that if those which had been dredged had not been taken they would have remained. In his opinion there never would be cheaper oysters until there was a natural reproduction, and that would only come when the weather was favourable. With regard to breeding, he should like to have a little further information. With regard to artificial breeding in Holland, he was inclined to think that it was a loss to those who undertook it. At Arcachon he had asked several of the great breeders, and they all told him that breeding oysters artificially did not pay. It paid individual fishermen who worked themselves, but it did not pay to breed on a large scale even at present prices. He thought the rents named in the paper were fancy prices, and should like to hear further particulars as to whether the matter was a commercial success, and he hoped there would be a further and more complete discussion on the whole question.

Mr. F. G. BROWNING (Whitstable) said that in the neighbourhood of Whitstable for the last 50, 60, or 80 years there had been more parent oysters than any person would think of stocking a new ground with, consequently it was not the want of parent oysters which caused the scarcity. But during the memory of man there had not been more than six or seven spatting seasons, and when there was abundance of spat it had been when the stock of parent oysters was reduced to the lowest ebb. He should also like to ask what was meant by ripe oysters carrying eggs, because he was under the impression that the spawn for all oysters was eggs.

The CHAIRMAN said they were all very much indebted to Professor Hubrecht for his very interesting Paper; but there were still several points left a little obscure, on which further light would be welcomed. Some of the remarks which had been made tended in some degree to a doubt as to the success of oyster-culture; but there was no doubt that beginning at Arcachon and finishing off in Holland, whatever were the methods adopted by the French, Belgians, or Dutch, they could claim at any rate the merit of success, for they had enormously re-stocked their ground and replenished their oyster-beds, and he could not think, that as regards climate, tides, and the possession of the estuaries on the coast, we were in such a totally different position, that we could not with the greatest advantage, imitate some of the methods by which this success had been obtained. It seemed desirable to separate the question of regulation from that of cultivation. With regard to that of regulation, foreign governments possessed a great advantage over our own, they could do many things which we could not do, and which it would be impolitic on our part to attempt, unless thoroughly supported by the great fishing industries of the country. With regard to all these questions, the first thing to do was to impress on the minds of the fishing population the necessity for these regulations, and that if carried out, although they must be irksome for a time, they would be eventually for their benefit. It was also very desirable that there should be further discussion on this point; but that hardly came within the scope of the present meeting. With regard to the cultivation of oysters, they had evidence of success in the quantity of breeding which took place on the coast of France, and he was rather surprised to hear from Captain Austin that it did not pay. He was aware that several companies had been established, and that a good many of them had been wound up, and therefore it was no doubt true that the smaller men had been the most successful commercially; still, the nett result was a production of a great mass of oysters, large reserve beds were kept, on the idea that from them a great portion of the spat was produced; but it must be remembered that the climatic resources of the country were considerable, and there was no doubt that owing to the higher temperature of the water at the critical period, oysters there had not the same difficulty to contend against as they had in England. In Holland, however, the climate could not be better than our own; but he believed the spat fell much later in the year, towards the end of July or August, and at that time, as he understood, the temperature of the water in the basin of the Scheldt would reach 70° Fah. If that were the case every year, it might have an important bearing on the production of oysters. He did not see that it could be the result of the climate; but it might be the result of currents of water—perhaps a portion of the Gulf Stream, which touched that part of the coast. The great advantage of the method pursued in Holland seemed to be this, that every year there was a fall of spat, filling the great basin which had been described, and the cultivators had nothing to do but to place their collectors above and below low water mark, in order to collect this natural floating spat. Now, it must be admitted that for many years past there had been no natural floating spat on the English oyster-beds at all. The question was, did that arise from the small stock of oysters, or was it entirely climatic? He could quite understand what had been said by Professor Hubrecht about the enormous advantage of leaving portions of the shore undisturbed where a large stock of oysters was maintained, and it was a well-known fact that the water near the shore was warmer than that further out. He had known the water in his river at Beaulieu from 75° to 78°, that temperature being produced by its water being so shallow. If, therefore, the breeding oyster lay within a short distance of the shore, he could perfectly understand that the warmth of the water would bring them forward to maturity, and thus this large quantity of spat might be derived. The breeding of oysters artificially in ponds had been tried in this country, and he had tried it himself; but whether from want of experience or carelessness, had not been successful in bringing any large quantity of the oysters which were bred to maturity. In 1878, he bred two ponds quite full of oysters, probably eight to ten millions; but he believed from 25,000 to 30,000 was as many as were ultimately realised. He could not attribute that to any failure of the climate; but he believed it was due to inexperience and mismanagement. In 1880, a large quantity of oysters were bred in ponds at Newtown in the Isle of Wight, and certainly, up to the season of 1881, they were in a most excellent condition, and if they had been properly cared for must have been saved and brought to maturity; but other matters interfered which prevented their being so. He did not believe there was any great difficulty in breeding oysters in ponds in this country, except that they were really at the mercy of the climate, because in shallow ponds the changes of temperature were so rapid, that the passage of a hail-storm over it would utterly destroy the whole of the spat that would be falling there. He had never thought it necessary to aerate the water; but let it in and out every day with the tide. The state of the oyster when in embryo, would rather lead to the conclusion that in the day he naturally floated to the surface towards the warmth of the sun, and at night, when it was dark, sank to the ground, so that it was not difficult by an arrangement of upper and lower sluices, to arrange for a continual flow of fresh water into the ponds. The greatest difficulty of all in breeding oysters, was the uncertainty of the fecundity of the spat itself. He had seen ponds perfectly full of spat, with every prospect of coming to maturity, and then found in a short time that it had all disappeared. There was a good deal of truth in what had been said about the collectors. There was nothing to which oysters would adhere in greater quantities than a smooth piece of slate, so that actual roughness did not appear to be a necessity; what they heard most about, was perfect cleanliness ; if anything grew on the collectors when the oyster-spat was forming, he was satisfied that the oyster would not fix on it, and finding the ground already covered by some other organism, it would die. That was one of the difficulties in pond culture, because the growth of seaweed itself in pools was much more rapid than in the sea, and if you were not fortunate enough to have the oyster-spat soon after the ponds were filled, the result was, that when they did spat, weeds were grown, and there was nothing for them to fix upon. Another great difficulty was the expense, and unless you could really secure a good fall of spat, it would not pay, unless you were fortunate enough to collect such a quantity in one year as would pay for several. The mortality in the oyster-spawn was one of the most remarkable features in the whole natural history of the oyster. The European oyster would produce over one million of eggs, and American oysters nearly five times as many, so that it was evident an enormous proportion must die. If by any knowledge they could acquire with regard to the regulation of the oyster fisheries, they could get a large reserve—not of course on muddy ground where they could not be left without moving—there seemed no physical difficulty in following the example of their friends in Holland, and collecting artificially the natural fall of the spat. If they took the area of the Solent or the mouth of the Thames, and thought of the enormous number of oysters which there ought to be in those districts, and how the tides must, owing to the natural eddies, flow backwards and forwards, one could hardly doubt that the spat might be collected, and it seemed to him that we might with advantage follow the system carried on there, and so do something to replenish our native beds. The British native oyster was the best that grew, though he was ready to give great credit to the Dutch oysters, which probably came next to it but it was a great mistake for any one to suppose that by bringing a French or Dutch oyster, and putting it into English beds, that it was converted into a native.

The MARQUIS OF EXETER then moved a vote of thanks to Professor Hubrecht for his valuable paper.

HIS EXCELLENCY COUNT BYLANDT had much pleasure in seconding the motion. He was very glad that some gentlemen present had touched one important subject in regard to artificial oyster-culture, viz., the temperature of water, but unfortunately that was a fact beyond human control. It was different in different countries, and we must all submit to the consequences. Some doubt had been expressed as to the success of the artificial oyster beds in the Netherlands, but it seemed to him that that question must be left to those who were willing to pay every year increasing rents to the Treasury for the beds they leased, and as to the figures which had been given there could be no doubt. One gentleman touched on an interesting subject when he referred to the desirability of international convention with regard to fishing. No doubt that was a matter of great importance, but how it could apply to oyster fishing he was at some loss to understand, because if he was not much mistaken oyster-culture meant the creating of artificial beds which were generally established within the territorial waters of every country, and where he did not believe foreigners were allowed to fish. For all other purposes the mutual interest of all nations was guaranteed by conventions, and he was quite sure his country would be ready to join in any convention for that purpose. He was so much a layman in this matter that he did not dare to go into any further details, but he might tell the meeting a little story, which might amuse them, and certainly puzzled him. The King of the Netherlands during his recent stay here reminded him that he had been appointed President of the Netherlands Committee, and therefore he should expect not only a lengthy report from him on the Exhibition, but also an essay on the possibility of getting fish without bones. He very much feared that even with the assistance of his friend Professor Hubrecht he should not be able to meet His Majesty's wishes except by sending him a specimen of the British oyster, which he believed was the only fish that answered the description.

The vote of thanks having been carried unanimously,

Professor HUBRECHT, in reply, said he might inform Count Bylandt that a fish without bones had already been found and was present in the Exhibition, but he regretted to say that its dimensions were so exceedingly small that it could never form an article of diet for the Royal table. With regard to the question Mr. Browning had brought forward as to the age at which the oyster produced eggs, he would remark that the eggs formed so to say the commencement of the spat, and only in a later stage of the development of the eggs, when they had been impregnated, they gradually changed into a state of larvæ, and these larvæ, which were afterwards set free in the sea water, formed what was called the spat of the oyster. The spat was nothing but the impregnated eggs, having become larvæ, swimming about freely a certain time, and afterwards fixing on to some object where they could grow into oysters. The age had been carefully investigated at which oysters produced eggs out of which spat could be evolved, and now it was quite clear that in the Scheldt only oysters of three or four years old contained such eggs. There was no instance of any oyster larvæ produced at an earlier age. The investigations of Dr. Hoek on this subject were published, and to them he would refer Mr. Browning. As to the question of certain oyster beds in Arcachon, as stated by Captain Austin, not having a vestige of spat, although there were a large number of mature oysters, he quite agreed with the possibility. The great question was, where had the spat that had been produced on this oyster bed gone to? As he had already stated, they did not know how long spat remained suspended, and it was generally believed that this might be three or four days, and thus the spat which had been set free out of the shells of the ripe oysters forming a given bed, might have been carried away by currents miles from the native place, and deposited elsewhere, or drifted away to sea without even growing to mature oysters. Next came the important point with respect to the "fall" of spat on the beds which were leased for the purpose. There was in all probability no region so favourable as the inland bay of the oyster Scheldt of which he had spoken. On many of the English beds situated on the coast, the moment the spat had been produced it might easily be carried away either to some distant point of the coast, or out to sea; but what happened in the Scheldt was somewhat different, and had been investigated very carefully. Each tide taking about six hours to ebb or flow, a floating object which also registered the deeper undercurrents—at least approximately—and which was set afloat above the oyster beds, had been carefully noticed at the beginning of the ebb. It of course went seawards; but it had not yet reached the ocean when the ebb was exhausted, and it was brought back again by the flood tide. It was greatly to this oscillating movement of a large bulk of water, which did not allow of the spat being so easily carried out to sea, that in his opinion must be ascribed the fertility of this region as an oyster producing locality. He feared that if the arrangement contemplated were carried out, and they were going to have oyster beds established in the Zuyderzee, they would have greater difficulties to contend with similar to those from which England and France were suffering, and they would have to look out carefully for some spot which in that respect more nearly resembled the situation of the Scheldt. As to whether the artificial oyster-culture had been a success he could not deal with that point at length, Count Bylandt having already referred to the figures. In addition, he might say that whereas in 1870 the neighbourhood of these beds only consisted of very poor hamlets, at present they were most flourishing villages, and some of the old lessees who had from 1870 to 1885 held allotments there had re-invested their money in the new leases beginning in 1885. Fancy prices might have been given in individual cases, but on the whole the increase from £1,700 to £28,000 as yearly rent for the same 8,000 acres was perfectly genuine. With regard to the observation made by the Chairman as to the disappearance of the spat, he could well conceive that when the spat had been produced in enclosed parks great mortality was observed, so that no real results were obtained; it was to a great extent caused by the water not containing enough oxygen. He had been occupied to some extent with embryological researches on various marine animals, and he had found that if he only took care that a fair supply of oxygen were pumped into the water he could develop many marine forms of animal life, and keep them healthy for a period of eight weeks and longer, in no greater space than a large tumbler, without ever changing the water. With regard to temperature, it had always been observed that it was necessary for the water to be 68° or 70° in order to get a large number of spat on the tiles. He concluded by moving a vote of thanks to Lord Henry Scott, who had honoured him by presiding on this occasion.

The motion was seconded by Dr. DAY, and carried unanimously.

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